TOTAL MAXIMUM DAILY LOAD ASSESSMENT

BARR LAKE AND MILTON RESERVOIR
COSPMS04
pH
ADAMS COUNTY AND WELD COUNTY, COLORADO
May 2013

<table>
<tr><th colspan="2">TMDL Summary</th></tr>
<tr><td>Waterbody Description / WBID/HUC</td><td>Barr Lake and Milton Reservoir, COSPMS04, 10190003</td></tr>
<tr><td>Pollutants Addressed</td><td>pH</td></tr>
<tr><td>Relevant Portion of Segment (as applicable)</td><td>All</td></tr>
<tr><td>Use Classifications / Designation</td><td>Aquatic Life Warm 2, Recreation E, Water Supply, Agriculture</td></tr>
<tr><td>Water Quality Target</td><td>
<table>
<tr><td>pH</td><td>9.0 s.u. (upper pH standard)</td></tr>
<tr><td>Total Phosphorus</td><td>0.100 mg/L (maximum)
0.040-0.060 mg/L (average)</td></tr>
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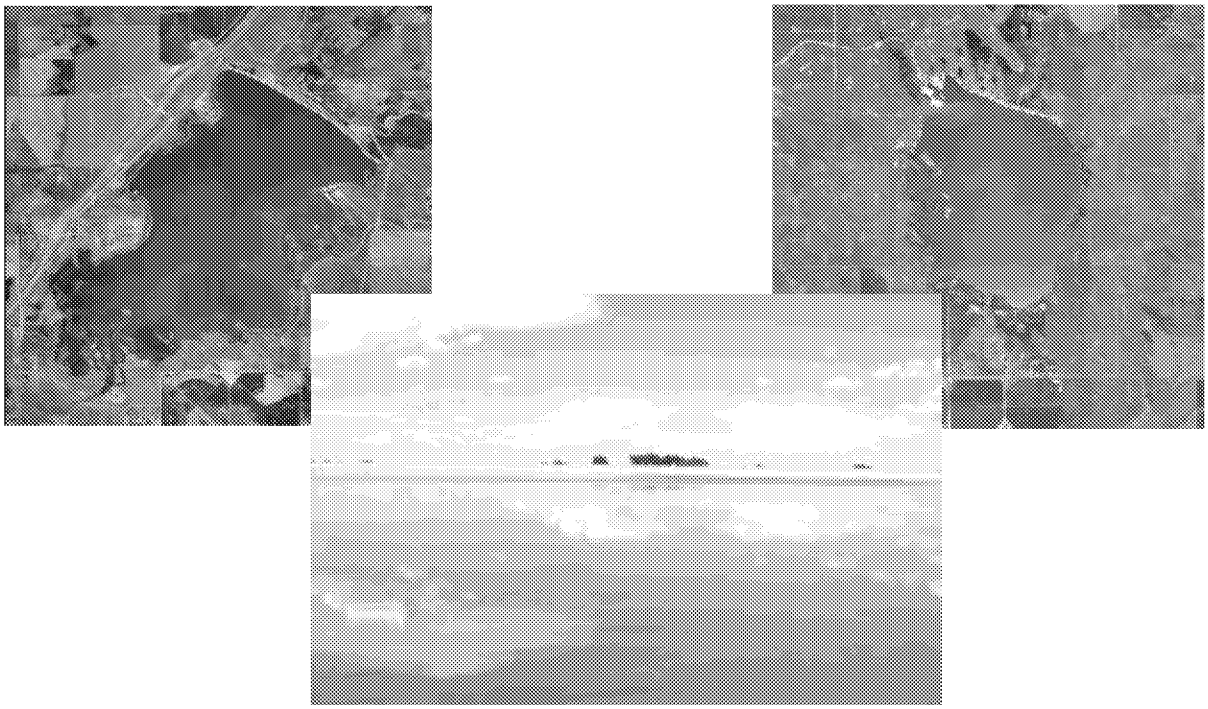
</td></tr>
<tr><td>TMDL Goal</td><td>Attainment of Aquatic Life, Recreation, and Water Supply use classification standards for pH.</td></tr>
</table>

Phased Total Maximum Daily Load to Achieve pH Compliance in Barr Lake and Milton Reservoir, Colorado



Prepared by the
Barr-Milton Watershed Association

With Assistance from:
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May 2013

Table of Contents

List of Tables

List of Figures

Section 1
Problem Description

Barr Lake (Barr) and Milton Reservoir (Milton) are two off-channel reservoirs located in the South Platte River (SPR) system northeast of Denver, Colorado. Both experience pH levels above the water quality standard, which requires that no more than 15% of measured values exceed 9.0 standard units (S.U.). A reduction in the frequency of high pH values is needed to meet water quality standards and support designated uses. This Total Maximum Daily Load (TMDL) has been developed to address pH exceedances in both water bodies.

Based on data collected between summer 2002 and the end of 2007 (*see* Table 1.1), the pH water quality standard is exceeded more than one quarter of the time throughout the water column in Barr and over one third of the time throughout the water column in Milton. Considering only the upper two meters of water from just late June into late September (summer season), the percentage of exceedances over time is larger, over half of the summer near the surface of Barr and over two thirds of the summer in the upper waters of Milton. Summer is the season of most pH standard exceedances, at roughly twice the number of exceedances of the other three seasons combined. This data set (2002 – 2007) forms the foundation for development of this TMDL.

Table 1.1 Summary of pH Data for Barr Lake and Milton Reservoir (2002-2007).

	Barr Lake				Milton Reservoir			
	All pH Data		Summer pH Data		All pH Data		Summer pH Data	
Variable	Upper 2m	Water Column	Upper 2m	Water Column	Upper 2m	Water Column	Upper 2m	Water Column
Count	111	111	44	44	110	110	42	42
Median	8.83	8.70	9.09	8.90	8.87	8.83	9.14	9.04
Mean	8.75	8.61	9.11	8.89	8.78	8.74	9.13	9.06
Range	2.62	2.67	1.67	1.91	2.75	2.64	1.43	1.33
Minimum	7.16	7.16	8.12	7.92	7.05	7.19	8.31	8.31
Maximum	9.78	9.83	9.78	9.83	9.79	9.83	9.74	9.64
% of Values >9.0	33.3%	27.0%	52.3%	36.4%	40.9%	35.5%	69.0%	59.5%
85th Percentile Value	9.32	9.29	9.54	9.42	9.32	9.30	9.38	9.35
Standard Deviation	0.559	0.587	0.389	0.460	0.547	0.551	0.334	0.323
Sample Variance	0.313	0.345	0.151	0.211	0.299	0.304	0.112	0.104
Standard Error	0.053	0.056	0.059	0.069	0.052	0.053	0.052	0.050
Confidence Level (95.0%)	0.105	0.110	0.118	0.140	0.103	0.104	0.104	0.101
Coefficient of Variation	0.064	0.068	0.043	0.052	0.062	0.063	0.037	0.036
Kurtosis	-0.432	-0.696	-0.001	-0.695	-0.046	0.044	0.487	-0.069
Skewness	-0.414	-0.285	-0.442	-0.194	-0.545	-0.611	-0.471	-0.347

Algal blooms in Barr and Milton are believed to cause the elevated pH through removal of carbon dioxide during photosynthesis. High pH levels initiated by algae are sustained by high alkalinity even after blooms subside. Algal blooms that cause elevated pH levels are dependent on supplies of nutrients and light within the water bodies and are also promoted by elevated temperatures.

While current total phosphorus (TP) levels are so high as to make factors other than TP limiting to algal growth, lowered TP has been documented to control algal growths and address related issues once the threshold of TP limitation has been reached (Paerl 2007, Carpenter 2008, Schindler et al. 2008).

Other nutrient loads, most notably nitrogen, may be limiting to algal growth now, but are not controllable to the degree necessary to achieve pH compliance. The ability of cyanobacteria (i.e., blue green algae) to utilize nitrogen gas dissolved in lakes at equilibrium with an atmosphere that is 78% nitrogen will

allow excessive cyanobacterial production at low levels of aqueous nitrate or ammonium nitrogen. Factors such as light and temperature are not practically controllable in these reservoirs. Therefore, this TMDL, when fully implemented, will meet the pH water quality standard by reducing the loading of TP to the Barr Lake and Milton Reservoir Watershed (BMW) system from both point and non-point sources (NPSs).

In addition to reducing external phosphorus loading, algal populations can be controlled by in-reservoir measures, including algaecide treatments, mixing, or inactivation of phosphorus once it has entered the reservoirs. There are also other ways to directly reduce pH, including aeration and mixing or direct addition of carbon dioxide. However, within the TMDL context, the primary focus is on limiting all controllable point sources and nonpoint sources (NPSs) of phosphorus to achieve the applicable pH water quality standard.

The BMW Association (Association) has developed this third-party TMDL using input from its members and other interested stakeholders. Association members include representatives of cities and towns, major wastewater treatment facilities, irrigation companies, drinking water providers, agricultural water users, Colorado State Parks, and recreational groups.

1.1 Justification for a Phased Approach

The Association has determined that a phased approach is appropriate for the BMW TMDL. According to U.S. Environmental Protection Agency (EPA) guidelines (EPA 2006), a phased approach for a TMDL is justified when the "available data only allow for 'estimates' of necessary load reductions or for 'non-traditional problems' where predictive tools may not be adequate to characterize the problem with a sufficient level of certainty." These descriptions are directly applicable to the Barr and Milton reservoirs as evidenced by the following considerations: (1)although it is widely accepted, scientifically, that there are qualitative linkages between pH, chorophyll *a* (chl), and total phosphorus (TP), a quantitative linkage hasn't been defined between the surrogate causal variable (phosphorus) and the in-reservoir response variables (pH and chlorophyll *a*), probably because the TP levels are too high too see the relationships; (2) limited available information regarding the complex watershed system, e.g., determining the appropriate watershed boundaries for calculating phosphorus loading; (3) internal reservoir loading contributions of phosphorus; and (4) the water budget for both reservoirs, e.g., the lawful exercise of water rights results in varying amounts of water being diverted to the reservoirs from year to year.

It is also clear that additional data and information must be collected in the future to better understand the relationship between the response variables (pH and chlorophyll *a*) and the phosphorus levels within the reservoirs. The Association has accepted the responsibility to refine and improve modeling efforts. These results will be incorporated into future refinements of watershed modeling activities, the Phased TMDL, and the TMDL Adaptive Implementation Plan (Plan). For example, additional data and information are expected to improve estimates of load and wasteload reductions needed to achieve compliance with the pH standard. These studies are currently scheduled to be implemented within the next five years.

A phased TMDL must include all elements of a "regular" TMDL, including load allocations, wasteload allocations, and a margin of safety (MOS). As with any TMDL, each phase must be established to attain and maintain all applicable water quality standards.

The Plan that accompanies this Phased TMDL includes a detailed description of immediate activities, additional monitoring, and special studies for modeling refinements. Although an implementation plan is not required for TMDL approval by EPA Region 8, the Association has developed an adaptive implementation plan for this Phased TMDL to ensure progress with respect to achieving the pH standard for both reservoirs. In the adaptive implementation approach, the Association will utilize the new information gained from activities completed following initial TMDL implementation efforts to appropriately target the next round of implementation activities and define activities for the second phase of the TMDL, if needed.

1.2 Identification of the Water Bodies, Impairment, and Study Boundaries

This Phased TMDL concerns both Barr Lake and Milton Reservoir, located in Middle South Platte Segment 4 (segment ID is COSPMS04). These water bodies are off-channel, man-made reservoirs connected to the SPR by canals and connected to each other by the Beebe Canal. Barr is located upstream of Milton. There are no permitted point source direct discharges to either reservoir, i.e., water containing treated effluent reaches the reservoirs solely through lawful water management activities. Both water bodies have been included on Colorado's 303(d) List as impaired for pH since 2002. Impairment is believed to be related to high loads of nutrients from the watershed and resulting eutrophication. At this time, nutrient criteria have not yet been established as enforceable water quality standards in the South Platte Basin.

Exceedance of the pH standard necessitates this Phased TMDL. Determining the appropriate study/watershed boundaries for development of this Phased TMDL is a complex issue. For example, the total land area that drains to the two targeted water bodies is very large, and determining how far "upstream" is appropriate for identification of potential phosphorus sources is complicated by existing nutrient-related control regulations that affect Cherry Creek Reservoir, Chatfield Reservoir, and Bear Creek Reservoir. To simplify issues related to identification of study boundaries and appropriate development of load and wasteload allocations, all loads and concentrations emanating from these three upstream reservoirs have been designated as "background" NPSs and the reservoirs themselves are not subject to any load or wasteload reductions at their releases, as discussed in Section 4.3.

1.2.1 Barr Lake and Milton Reservoir Description

Barr Lake is an off-stream reservoir located southeast of Brighton, Colorado. Barr has public access and has been a part of the State's park system since 1976. Barr has a capacity of just over 30,000 acre-feet and varies between 10,000 acre-feet (11.6 million cubic meters) and 30,000 acre-feet (37.1 million cubic meters) over the course of the irrigation season. When full, it covers 1,833 acres (742 ha) at an average depth of 16.4 feet (5.0 meters) and a maximum depth of 34 feet (10.4 meters). Large areas are exposed as the reservoir level declines from releases over the course of the irrigation season. The largest volume of flow enters Barr through the Burlington-O'Brian Canal that diverts water from Segment 14 of the SPR in the north part of the City and County of Denver.

Both Barr and the Burlington-O'Brian Canal are owned and operated by the Farmers Reservoir and Irrigation Company (FRICO). Water exiting Barr is currently used for agricultural irrigation, but part of Barr is a State Park and reservoir water is used indirectly for drinking water purposes via shallow groundwater withdrawals downstream of the reservoir. Fishing and boating also take place at Barr. Channel catfish, smallmouth and largemouth bass, rainbow trout, walleye, bluegill, wiper, and tiger muskie are among the species Colorado Division of Wildlife stocks at Barr. However, swimming is not permitted.

Milton Reservoir is a private, off-stream reservoir situated approximately 30 miles northeast of Barr. Milton has a capacity of just over 24,000 acre-feet and typically varies between 10,000 acre-feet (11.6 million cubic meters) and 24,000 acre-feet (29.6 million cubic meters) over the course of the irrigation season. When full, it covers 2,082 acres (843 hectares) at an average depth of 11.5 ft (3.5 meters) and a maximum depth of 26.4 ft (8.1 meters). Large areas are exposed as the reservoir level declines from releases over the course of the irrigation season. The largest inflow enters Milton via the Platte Valley Canal that diverts from Segment 1a of the Middle South Platte reach, north (downstream) of Fort Lupton. Water released from Barr can also flow into Milton through the Beebe Canal, and this canal can also drain some of the land between Barr and Milton.

FRICO owns and operates Milton and the Beebe Canal for agricultural purposes. In addition, Milton is used for recreation, including boating and waterfowl hunting under a lease to the Beebe Draw Municipal District. However, there is no public access to the reservoir.

1.2.2 pH Impairment

Barr and Milton are included on the 303(d) List as exceeding the pH standard of 9.0 S.U. The pH values for both reservoirs most often exceed 9.0 S.U. from June to October, coinciding with algae blooms in the summer season, although winter exceedances have been recorded as well. As shown in Table 1.1, average summer pH is close to 9.0 S.U. in both reservoirs, and the average annual pH is near 8.7 S.U. in each.

The pH standard applies to Aquatic Life Use, Domestic Water Supply Use, and Recreation Use. The Agriculture Use does not have a pH standard, although high pH levels are not considered optimal for irrigation use. The Colorado Department of Public Health and Environment (CDPHE) rates the Barr and Milton pH 303(d) listing priority as "medium."

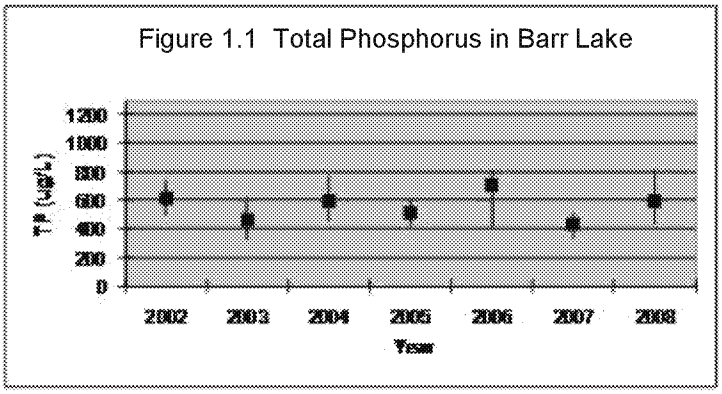
Concentrations of phosphorus are very high in both Barr and Milton. Values from 2002 through 2008 are provided in Figures 1.1 and 1.2. Chlorophyll *a* (Chl) values also can be very high at any time, depending on light, temperature, mixing, and other non-nutrient related factors.

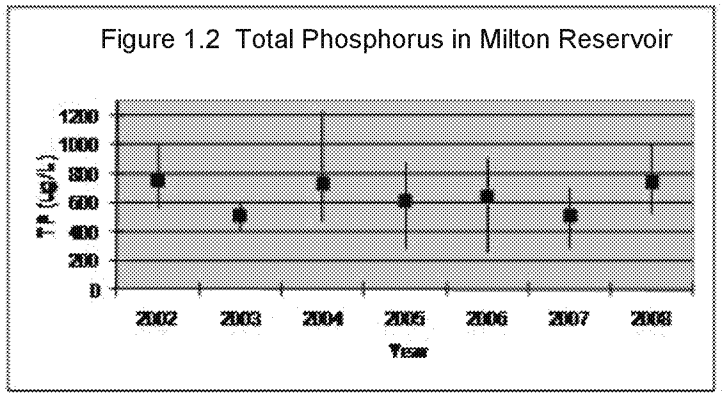
Winter blooms of diatoms can raise the pH above 9.0 S.U., but not as often or for as long as cyanobacteria blooms during the summer months. At the existing phosphorus levels, temperature is the primary determinant of algal composition in these reservoirs, and light is most likely the limiting factor for biomass. Phosphorus concentrations are well above the threshold for diminishing control of algal productivity (Van Nieuwenhuyse and Jones 1996, Havens and Nurnberg 2004). The ability of the cyanobacteria to float and form scums is likely responsible for the higher pH in surface waters compared to the whole water column as shown in Table 1.1.

1.2.3 Study Boundaries and Point Sources

The BMW is very large, extending well south of Denver along the path of the SPR, and north from Denver onto the plains, with Barr and Milton as the defined terminal points (Figure 1.3). However, not all water from the watershed passes through these reservoirs, as neither is located directly on the SPR. Instead, diversions from the SPR represent the primary source of water for the two reservoirs. Although the watershed extends well south (upstream) of Denver, this effort is focused on the portion of the watershed from Denver downstream to Barr and Milton because this is the area where most of the flows and phosphorus loads that are diverted to the reservoirs originate.

For purposes of this effort, the watershed has been simplified to an area termed the "datashed" (BMW 2008). The datashed covers over 833 square miles (533,000 acres) on the central Colorado plains and encompasses portions of six counties: Adams, Weld, Arapahoe, Denver, Jefferson, and Douglas (Figure 1.4). The watershed generally flows south to north, paralleling the foothills of the Front Range of the Rocky Mountains located to the west. Over 500 miles of streams and rivers drain this area. Adding to the hydrologic complexity of the watershed, these natural waterways are supplemented by over 550 miles of man-made canals, ditches, and pipelines (BMW 2008). The drainage system south and west of the Denver metropolitan area is captured by reservoirs and several creeks that are monitored and can be treated as distinct inputs to the datashed. From here on, the term "watershed" will be used synonymously with "datashed."





Note: Squares represent mean annual values, while bars represent the range of measured values.

Figure 1.3 Barr Lake and Milton Reservoir Watershed

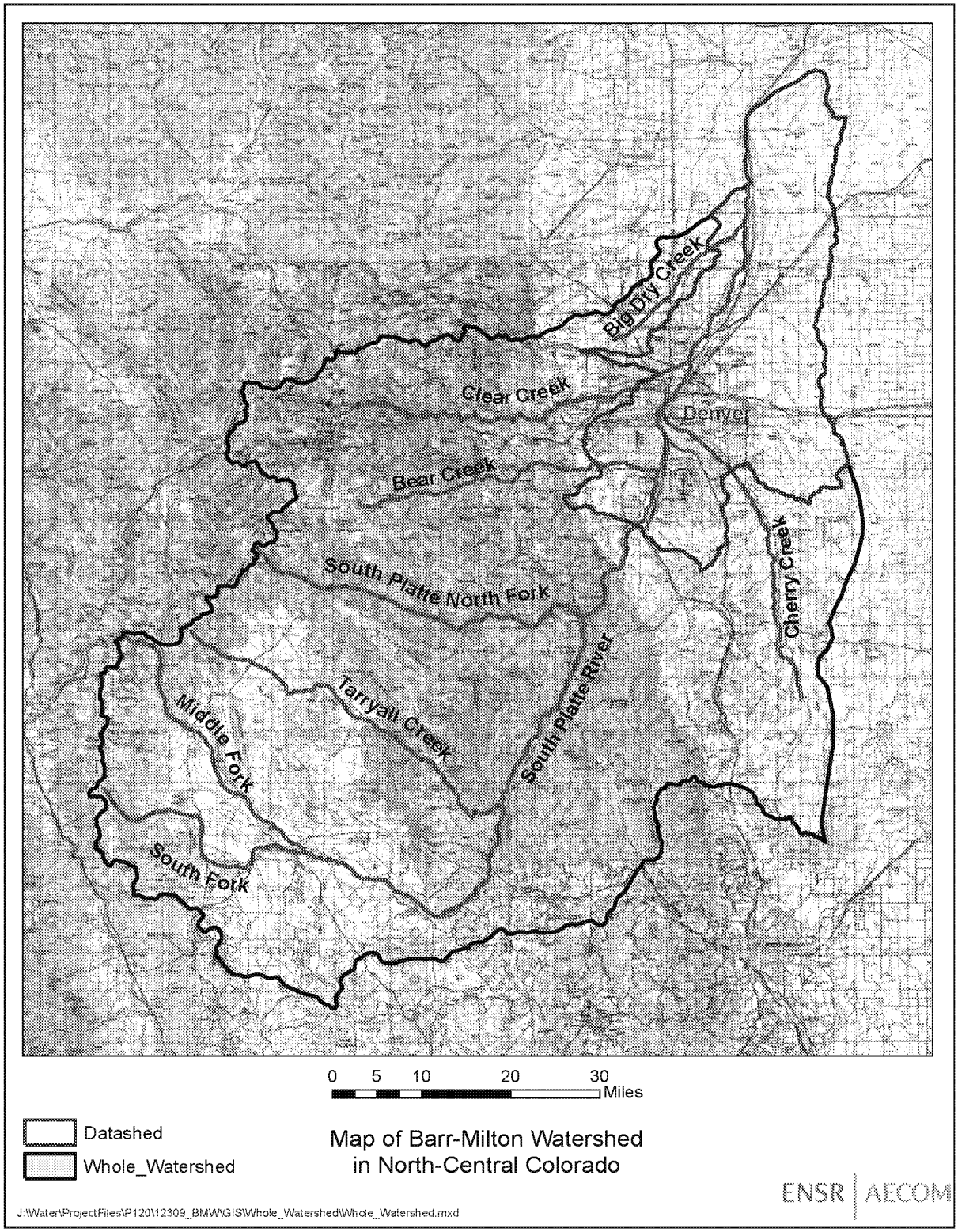
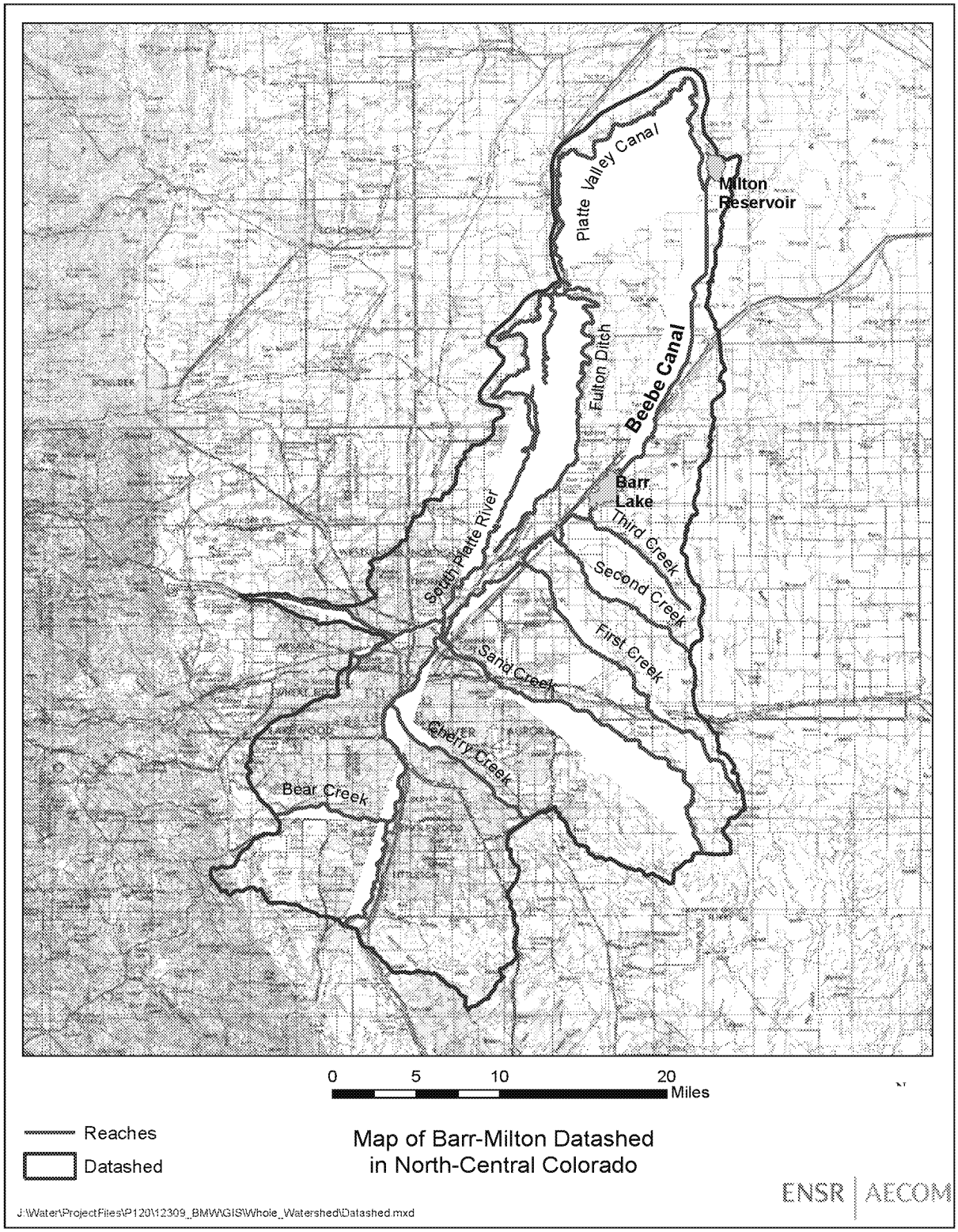


Figure 1.4 Barr-Milton (BMW) Datashed.



Approximately 89% of the BMW is privately owned. Nearly 55% of the watershed supports agriculture, including grasslands, pasture, small grains, and row crops. Residential, commercial, and industrial areas, including most of the Denver metropolitan area, cover 38% of the watershed and are located primarily in the southwestern extent of the datashed and along the SPR. Less than 2% of the watershed is covered by open lands (BMW 2008). The BMW area includes over 75% of the Denver metropolitan area.

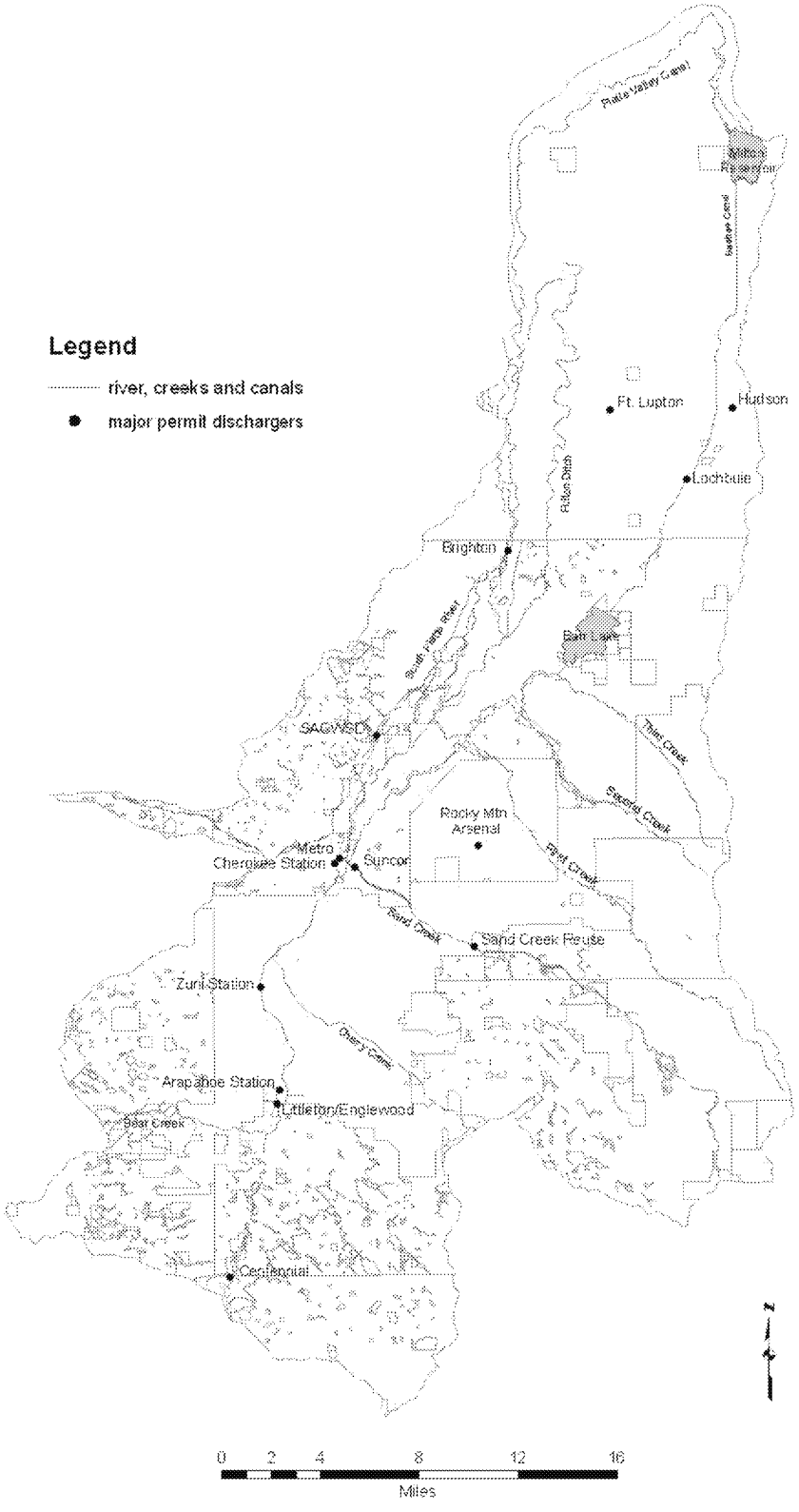
There are a number of major dischargers that hold National Pollutant Discharge Elimination System (NPDES) permits in the watershed, including industrial, wastewater, and drinking water treatment facilities. These are listed in Table 1.2 and a map of the major industrial and municipal wastewater dischargers is provided on Figure 1.5. Due to the influence of permitted discharges from publicly owned treatment works (POTWs, also referred to as wastewater treatment plants, or WWTPs) portions of the main stem of the SPR through the watershed (Upper South Platte Segment 15 and Middle South Platte Segment 1a) can be described as effluent dominated (BMW 2008). However, based on the modeling studies for this effort, not all of the major dischargers are included in the TMDL phosphorus allocation scheme discussed in Section 4.

Table 1.2 Major NPDES Permittees in Barr Milton Watershed* (as of July 23, 2010).

Facility Name	Location	Permit Expiration Date	SIC Code	SIC Description
Brighton	Brighton	Jan-31-2007	4952	Sewerage
Metro Wastewater Reclamation District (Robert W. Hite Treatment Facility)	Commerce City	Feb-28-2013	4952	Sewerage
South Adams County Water and Sanitation	Commerce City	Jul-31-2015	4952	Sewerage
Suncor Denver Refinery	Commerce City	Oct-31-2011	2911	Petroleum Refining
Fort Lupton	Fort Lupton	May-31-2011	4952	Sewerage
Lochbuie, Town of	Lochbuie	Dec-31-2010	4952	Sewerage
Littleton/Englewood	Englewood	Oct-31-2014	4952	Sewerage
Sand Creek Reuse	Aurora	Oct-31-2011	4952	Sewerage
Arapahoe Station	Denver	Dec-31-2012	4911	Electricity
Cherokee Station	Denver	Apr-30-2014	4911	Electricity
Zuni Station	Denver	Apr-30-2014	4911	Electricity
Centennial Water & Sanitation	Highlands Ranch	Administratively Extended	4952	Sewerage
Hudson	Hudson	Administratively Extended	4952	Sewerage

* Facilities shown in bold italics are subject to proposed wasteload allocations.
Note - NPDES data are from EPA Permit Compliance System.

Figure 1.5 Major Industrial and Municipal Wastewater Dischargers in Datashed.



There are also three individual Municipal Separate Storm Sewer System (MS4) permits in place (Denver, Aurora, and Lakewood), plus an MS4 permit covering the Colorado Department of Transportation facilities and activities in this area. Many smaller communities in the urbanized area around Denver are covered by Phase II general stormwater permits. These MS4 permits are listed in Table 1.3.

Table 1.3 Stormwater **Phase I and Phase II City and County Permittees in the BMW* (as of March 10, 2010).**

Permit Number	Permittee Name	Permitting Phase
COS000003	Aurora, City of	Phase I
COS000005	Colorado Dept of Transportation	Phase I
COS000001	Denver, City & County of	Phase I
COS000002	Lakewood, City of	Phase I
COR090041	Adams County	Phase II
COR080010	Arapahoe County	Phase II
COR090013	Arvada, City of	Phase II
COR090089	Brighton, City of	Phase II
COR090066	Cherry Hills Village, City of	Phase II
COR090032	Commerce City, City of	Phase II
COR080003	Douglas County	Phase II
COR090068	Edgewater, City of	Phase II
COR090056	Englewood, City of	Phase II
COR090038	Federal Heights, City of	Phase II
COR090003	Glendale, City of	Phase II
COR080004	Greenwood Village, City of	Phase II
COR090024	Jefferson County	Phase II
COR090055	Littleton, City of	Phase II
COR080016	Lone Tree, City of	Phase II
COR090082	Sheridan, City of	Phase II
COR080021	Centennial, City of (Southwest Metro Stormwater Authority)	Phase II
COR090034	Thornton, City of	Phase II
COR090037	Weld County	Phase II
COR090015	Wheat Ridge, City of	Phase II

*All of these stormwater permittees are subject to proposed wasteload allocations.
Note – MS4 data are from Colorado Department of Public Health and Environment – Water Quality Control Division

1.3 Water Quality Standard - pH

Barr and Milton (Middle South Platte Segment 4) have the following classified uses:

- Domestic Water Supply
- Aquatic Life Warm Water Class 2
- Recreation Class E
- Agriculture

The antidegradation designation for Middle South Platte Segment 4 is "use protected." For pH, the applicable water quality standard is 6.5 to 9.0 S.U. for all uses (except for agriculture, which has no pH standard). Higher values are acceptable for up to 15% of the time.

Under current conditions, Barr and Milton have pH levels that exceed the water quality standard. Central to this Phased TMDL is the assumption that pH values greater than 9.0 S.U. are a function of algal activity (i.e., photosynthesis by algae raises the pH). Yet other factors, including precipitation, geology, and the composition of river water, will also affect pH in ways largely independent of algal blooms. The background pH for other reservoirs in the area appears to be no lower than 7.6 S.U. (AECOM 2009), but the alkalinity in both Barr (mean of 162 mg/L) and Milton (mean of 178 mg/L) are elevated compared to reservoirs in the area. Due to their elevated alkalinity, Barr and Milton can be expected to have average pH values between 8.4 and 8.6 S.U. when at equilibrium with the atmosphere, even without considering algal activity. There are multiple ways to achieve pH compliance, but this Phased TMDL has been developed to control pH by limiting phosphorus loading to and within the reservoirs.

Section 2

Water Quality Targets

In this section, water quality targets and assumptions will be explained for alkalinity, chl-a, and TP. The water quality target for TP is supported by multiple lines of evidence (statistical approach, modeled pH and TP relationships, chl-a linkage, and several North American empirical models) that point to a maximum summer season TP of 100 µg/L, which equates to a TP summer season average of 40-60 ug/L for Barr and 46-69 ug/L for Milton. Using multiple approaches to develop the TP target increases confidence that this Phased TMDL will bring the reservoirs into compliance with the pH standard

This Phased TMDL is intended to reduce the pH in Barr and Milton so that the water quality standard for pH is met. Based on a thorough review of the water quality data relevant to eutrophication, it is believed that pH values higher than the standard are a result of excessive algal growth which is related to excessive nutrients in the water column. Phosphorus is the preferred target for pH management. This Phased TMDL sets a TP target in the reservoirs that represents the highest TP level that will result in compliance with the pH water quality standard.

The TP target is based on relationships among pH, Chl, and TP. Relationships for these variables were assessed using data from the BMW system, nearby reservoirs, and eutrophication literature. This assessment process is described in more detail in "Watershed and Lake Modeling for a TMDL Evaluation of Barr Lake and Milton Reservoir" (AECOM 2009), in Section 3 of that report.

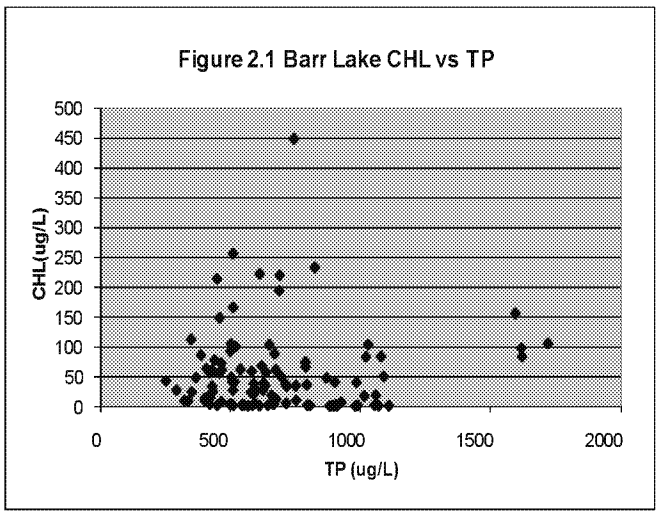
In general, relationships among TP, Chl, and pH in data from the BMW system are difficult to characterize because the dataset is dominated by high TP values, especially in the summer. TP and Chl are not closely correlated because, at the high TP levels in the BMW system, other factors limit the algal growth (including light, temperature, and even carbon). However, with reductions in TP, nutrients will become the limiting factor, resulting in lower Chl concentrations. The key is determining at what TP level sufficient control over Chl will be exercised. Figures 2.1 and 2.2 illustrate the relationship between Chl and TP in Barr and Milton based on data from 2002 through 2007. Note that for the very few low TP values encountered in Milton, Chl values were also low.

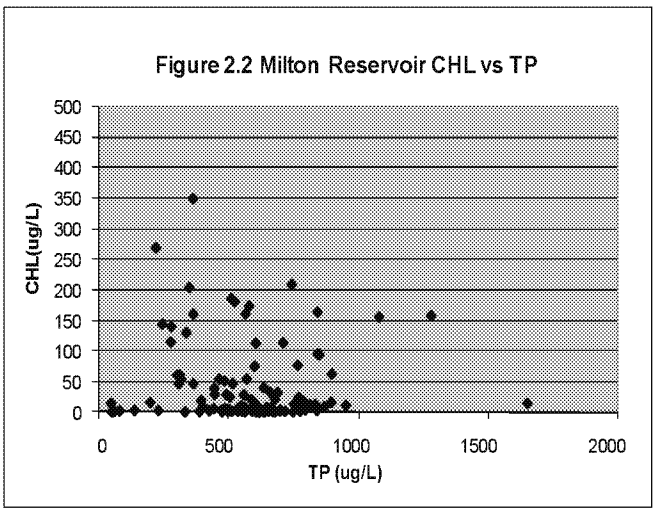
The lack of strong correlation between pH and Chl is partly a function of high alkalinity levels, which maintains high pH as a function of equilibrium chemistry. A pH near 6.0 S.U. would be expected with no alkalinity, based on the forms of carbon present at equilibrium between the water and the atmosphere (Stumm and Morgan 1996). At the alkalinities observed in Barr and Milton, pH values on the order of 8.5 would be expected at equilibrium. Higher alkalinities also resist pH change to a greater extent, however, so it could require the same level of photosynthesis to raise the pH above 9.0 S.U. from a lower alkalinity than from a higher one. Additionally, high Chl can inhibit photosynthesis as light becomes limiting, leading to some lower pH values at higher Chl levels. Photosynthetic activity is not directly proportional to Chl over the range of Chl levels. Figures 2.3 and 2.4 illustrate the relationship between pH and Chl in Barr and Milton based on data from 2002 through 2007. Lower pH values coincide with lower Chl levels, but the relationship is not strong.

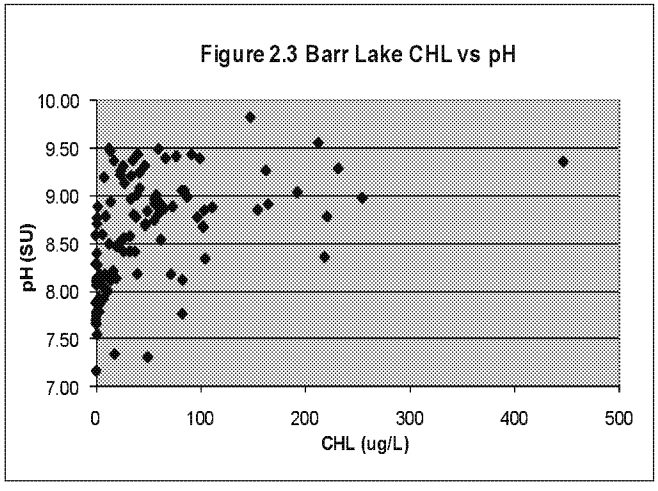
Focusing on the summer relationship between pH and TP, there is no basis other than extrapolation to determine at what TP level an acceptable pH will be attained. This is the most important reason for developing a Phased TMDL for these reservoirs. In other words, the target TP is outside the data ranges and modeling ranges for determining exactly how the pH will respond when TP levels are reduced. This is why dashed lines are shown in Figures 2.5 and 2.6.

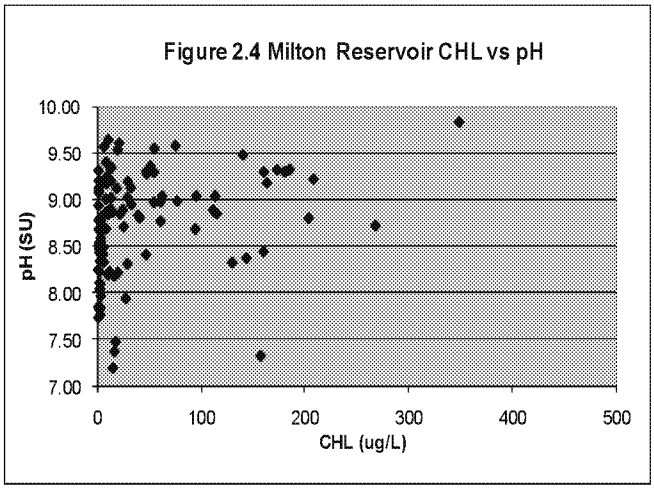
All TP values in these reservoirs during summer are in excess of 0.2 mg/L (Figures 2.5 and 2.6), a generally recognized threshold above which there is more than enough TP to fuel algal blooms and other factors will be limiting to algae. From regressions of Chl and pH for other area reservoirs, it is apparent that the

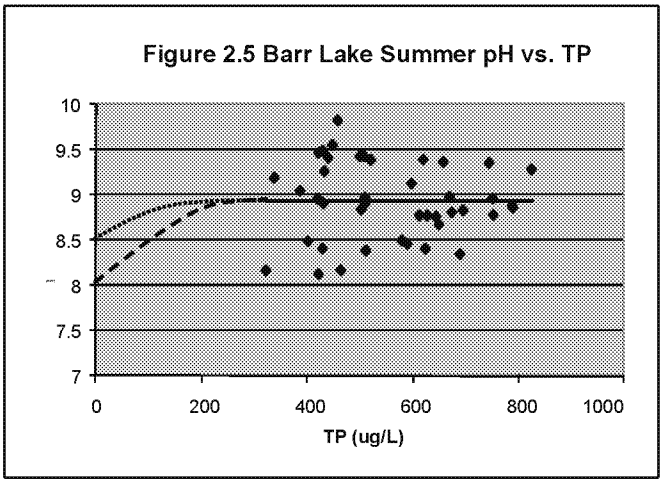
background pH in these reservoirs in the absence of Chl would be on the order of 7.6 S.U. (AECOM 2009). From alkalinity data for Barr and Milton, it is expected that the background pH without Chl would average about 8.5 S.U. From professional experience and many empirical graphic analyses (Havens and Nurnberg 2004), a much tighter correlation between pH and TP is expected at TP levels <100 µg/L. Figures 2.5 and 2.6 show what the TP-Chl relationship might look like when TP in Barr and Milton falls below 100 ug/L.

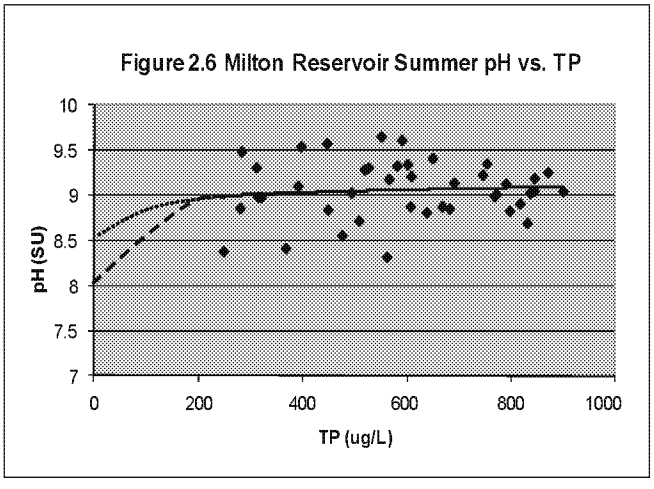












Note that points represent water column means for pH and epilimnetic values for TP and Chl for individual dates from 2002 through 2007. The dotted line signifies the expected pH trajectory with an equilibrium pH of 8.5 (based on current alkalinity) while the dashed line represents the expected pH trajectory with an equilibrium pH of 8.0 (based on alkalinity in Omernik and Griffith 1986, Love et al. 2007).

Taking a statistical approach, the coefficient of variation (CV) derived for pH data (Table 1.1) and the resulting standard deviation (SD) can be used to determine at what average pH the standard would be met. To have the pH exceed 9.0 S.U. no more than 15% of the time, the average pH + 1.08 X SD should equal 9.0 S.U. The 1.08 factor is based on the portion of a normal distribution associated with multiples of the SD. At 1.08 SD, 15% of all values can be expected to exceed the corresponding pH value, which is set at 9.0 S.U. Applying the summer whole water column pH CV of 0.052 for Barr and solving iteratively, an average pH of 8.53 S.U. would be expected to have a standard deviation of 0.444 S.U. and the 85th percentile for pH would be 9.0 S.U. The same process for Milton, using its summer pH CV of 0.036, yields an average pH of 8.67 S.U. to achieve the pH standard of 9.0 S.U. at least 85% of the time.

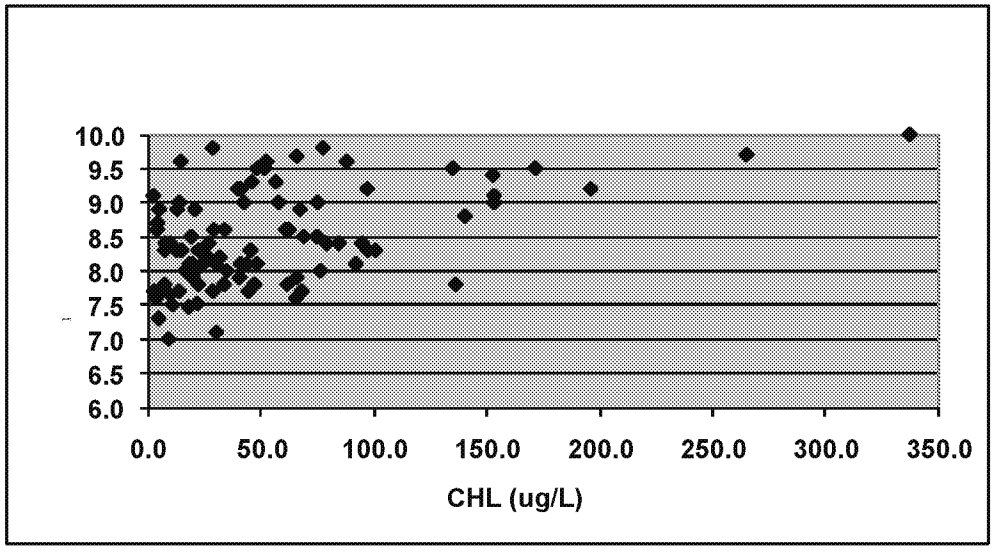
In the absence of substantial biological activity (i.e., either photosynthesis that raises pH or respiration that lowers pH) the pH would be determined mainly by equilibrium of carbon forms between the atmosphere and the reservoirs, which is mainly a function of alkalinity. Under the current alkalinity, the equilibrium pH would be close to 8.5 S.U. in each reservoir, leaving very little room for photosynthetic activity to outstrip respiration without exceeding a pH of 9.0 S.U. more than 15% of the time. The presence of any phosphorus would likely cause algal growth, which would raise the average pH and increase the risk of exceeding the standard given the expected variability in pH levels. Therefore, if the baseline alkalinity is not altered, there is little chance that phosphorus loads can be reduced sufficiently to limit algal productivity and meet the pH standard.

Fortunately, actions to reduce TP loads to the reservoirs from the watershed are likely to also lower alkalinity, so it is reasonable to assume that a lower baseline pH will be achieved. The map of background alkalinity produced for the western U.S. by Omernik and Griffith (1986) suggests background alkalinities for this area of 50 to 100 mg/L (as $CaCO_3$ equivalents). The more recent work of the South Adams County Water and Sanitation District (Love et al. 2007) suggests an alkalinity for the SPR upstream of the major urban inputs (including wastewater discharges) of 90 to 100 mg/L. At an alkalinity of 50 mg/L, the equilibrium pH would be close to 7.6 S.U., while at 95 mg/L it would be about 8.0 S.U. Uncertainty about the future alkalinity and how it may complicate target settling will be the subject of additional research, as outlined in the Plan.

For the purposes of this Phased TMDL, a baseline alkalinity of 95 mg/L has been assumed, resulting in a baseline pH of 8.0 before any consideration of respiration or photosynthetic impacts on Barr or Milton. The expected trajectory of pH as TP is lowered is presented two ways in Figures 2.5 and 2.6 – with the current alkalinity of each reservoir (162 to 178 mg/L) and with a projected alkalinity of 95 mg/L. From the projected relationship of pH and TP in Figures 2.5 and 2.6, it appears that a maximum TP concentration of 100 µg/L would yield a pH distribution that will not exceed 9.0 S.U. for more than 15% of the time in both reservoirs. An average summer pH close to 8.5 S.U. would be expected in each reservoir. It is possible that the baseline pH could be lower, as low as 7.6 S.U. with lower alkalinity, but alkalinity near the high end of the expected background range has been assumed in this analysis.

An alternative approach to setting a TP target involves assessing the allowable concentration of Chl in the reservoirs and then setting a TP target that corresponds to that Chl level. The Chl value above which a pH >9.0 S.U. represents 15% of the values in Barr is about 21 µg/L (Figure 2.3), as described by AECOM (2009). For Milton, that value is only about 7 µg/L, because the pH of the water is conditioned by the SPR and Barr and, as a result, is higher to begin with. Application of the Barr value to Milton is recommended, for consistency and in light of expected changes in Milton as a function of improvements made in Barr. Data from other Denver area reservoirs with some wastewater influence suggest that a Chl value of 25 µg/L will yield a pH of <9.0 S.U. for 85% of the time (Figure 2.7), as described by AECOM (2009). Included in this assessment were data provided by Denver's Department of Environmental Health from summer periods without extensive benthic algal mats or dense rooted plant growths for the following 15 reservoirs: Berkeley, Rocky Mountain, Sloan, Grasmere, Smith, Ferril, Duck, Harvey, Garfield, Huston, Overland, AquaGolf, Barnum, Vanderbilt, and Lollipop.

Figure 2.7 Chlorophyll (CHL) vs. pH for Denver Area Reservoirs



Application of a series of North American empirical models for estimating Chl from TP suggests a TP value of 50 µg/L to achieve a Chl value of 25 µg/L (AECOM 2009). These empirical models were not derived from data for plains lakes and the models may underestimate the tolerable TP level in Barr or Milton (Gelder et al. 2003). Knowledge of the Chl-TP relationship for reservoirs like those in the Denver area suggests that a TP value twice that obtained from the empirical models would be appropriate (Smith et al. 2001, Hakanson et al. 2005, Dodds et al. 2006; Robertson et al. 2007), or about 100 µg/L. This has been attributed to the role of calcium in binding phosphorus and limiting its availability. The sediment data generated for Barr support this contention; calcium-bound phosphorus was two to three times more abundant than iron- or aluminum-bound phosphorus in samples tested by the Metro Wastewater Reclamation District (Metro District) (Lundt, unpublished data).

Based on the convergence of results from different approaches, a value of 100 µg/L has been selected as the initial TP target for achieving pH compliance. This target TP value should correspond to a Chl value near 25 µg/L in Barr and eventually in Milton as Barr Lake TP reductions occur. These TP and Chl targets may require modification as water quality improves and the relationship among TP, Chl, and pH is further refined. It is suggested that a summer maximum TP of100 µg/L be the primary management target, with Chl tracked as a secondary variable to guide implementation refinement.

Based on a simple Vollenweider analysis, the threshold TP loads for Barr and Milton are about 3,950 kg/yr and 3,550 kg/yr, respectively. However, as noted above, lakes where calcium is an important TP binder can tolerate higher loadings and concentrations; loads twice as high may be accommodated without major negative impacts, based on observations in other systems. Conservatively allowing for a 50% greater load, TP loading ranges of 3,950 to 5,900 kg/yr for Barr and 3,550 to 5,300 kg/yr for Milton are expected to be appropriate. From the various empirical models available (Kirchner and Dillon 1975, Vollenweider 1975, Jones and Bachmann 1976, Larsen and Mercier 1976, Reckhow 1977), the predicted mean annual TP from these loads is 40 to 60 µg/L for Barr and 46 to 69 µg/L for Milton. With the known variability in TP in these reservoirs (Figures 1.1 and 1.2), the predicted average TP in the reservoirs is expected to lead to summer maxima near 100 µg/L.

Section 3

Total Phosphorus Source Analysis

TP loading in the BMW is complicated due to the influence of numerous water management activities within the watershed (AECOM 2009). Flows to Barr and Milton occur mainly through water transfers from the SPR and from Barr to Milton. Figure 3.1 shows a simplified schematic of the movement of water through this system and is based on the watershed breakdown generated for the combined lake model utilized by AECOM (2009). This figure indicates the primary pathways of flow, including sub-watersheds and discharges. Water quality in the reservoirs is largely determined by inputs from the SPR. Water quality in the SPR is influenced by releases from upstream reservoirs, inflows from a few streams north of Denver, and discharges from wastewater treatment facilities. Wastewater treatment plant (WWTP) effluents dominate the quantity of water in the SPR north (downstream) of Denver much of the year.

The Association conducted reservoir assessments for both reservoirs in 2008 (AMEC) to establish baseline conditions and to estimate water and TP budgets. In 2009, AECOM modeled the watershed TP loads using the SWAT (Surface Water Assessment Tool) and linked those loads to the in-reservoir model WASP (Water quality Analysis Simulation Program). These two models were used to run various scenarios to determine linkages among pH, chl-a, and TP loads. Independent verification by an outside consultant (Lewis and McCutchan 2009) verified the TP loading estimates. All three evaluations were relatively similar with some minor discrepancies. Using all three loading evaluations AECOM refined the estimates of TP loads.

The irrigation year (November 1 – October 31) is the most relevant period for understanding reservoir hydrology. After a season of irrigation, the reservoirs are at a low point in most years at the start of November, often at no more than a third of capacity. Refill commences about this time, and continues until the reservoirs are full except in years of low streamflow, when the reservoirs may never reach full status. Refill is normally completed in March, but has continued into May in some years, depending on the precipitation pattern and snowmelt.

Water is diverted from the SPR to fill both reservoirs. With the onset of the growing season in the spring, water is released from Barr and Milton into canals from which it can be used in various agricultural operations. Additional water enters the reservoirs over the growing season, as supply and water rights allow, but most of the water enters the reservoir during the winter half of the year, with net losses during the summer half of the year. Some irrigation return water also enters Milton via Beebe Canal from upstream irrigated agriculture, but overall the hydrologic inputs after refill is complete are lower and more erratic. Water levels in the reservoirs decline through the growing season, after which refill begins anew.

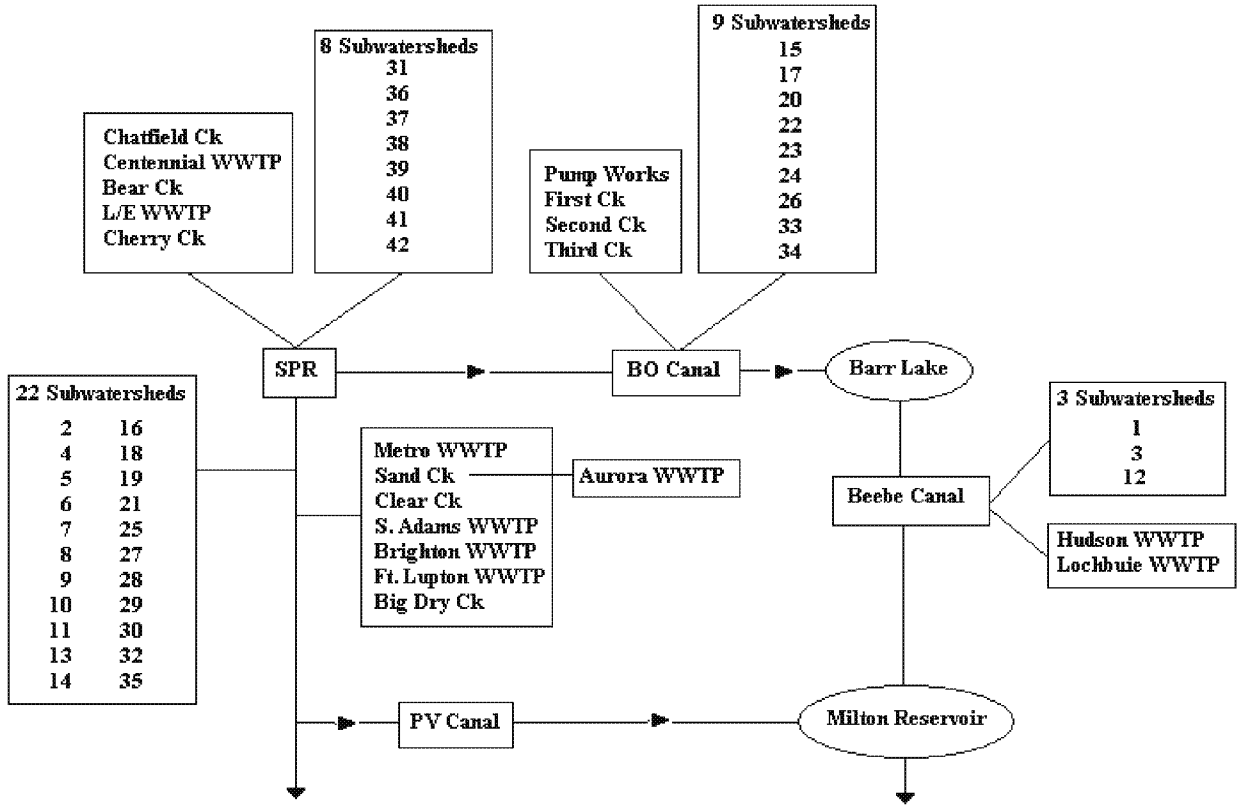
The diversion point for the SPR to Barr, the Burlington-O'Brian Canal, is downstream of the Littleton and Englewood WWTP (L/E) discharge to the SPR, and also downstream of the much smaller discharge from the Centennial WWTP. L/E has the greatest influence on Barr TP loading, which is more than an order of magnitude greater than Centennial in terms of TP load.

The largest discharge into the SPR within the study area is from the Metro District's Robert W. Hite Treatment Facility (RWHTF), which is downstream of the diversion to the Burlington-O'Brian Canal. Effluent from the RWHTF historically has been pumped directly to the Burlington-O'Brian Canal through the Burlington Pump Works (Pump Works). The Pump Works are located at the RWHTF and are owned and operated by Denver Water for water rights purposes. However, the discharge of RWHTF effluent via the Pump Works has been halted since 2008 by a water rights court case. One of the management scenarios simulated by AECOM (2009) involved cessation of the RWHTF discharge via the Pump Works, but the Pump Works discharge has been factored into loading to Barr for the data collection period applied to this phased TMDL effort, as the Pump Works were turned off after the modeling period for this Phased TMDL.

Milton is filled from the SPR via the Platte Valley Canal and, to a lesser extent, from Barr via the Beebe Canal. Downstream of the RWHTF discharge, three more small WWTP discharges enter the SPR

upstream of the Platte Valley Canal (South Adams County Water and Sanitation District, Brighton, and Ft Lupton). Two very small WWTP discharges enter the Beebe Canal between Barr and Milton at certain times of the year (Lochbuie and Hudson). On a volume basis, water diverted from the SPR that originates as effluent from the RWHTF is a dominant influence on Milton. Inflows to the SPR are strongly linked to spring snowmelt and more continuous wastewater discharges north of Denver. Withdrawals vary spatially and are dominated by agricultural uses, although some communities utilize SPR water as a drinking water source.

Figure 3.1 Simplified Schematic of the Barr-Milton Watershed



Water inputs to Barr and Milton vary significantly over time as a result of refill over the winter following irrigation use during the summer. The complexity of the system, with differing inputs over space and time, makes it difficult to track specific inputs on a simple mass balance basis. Therefore, the contributions from identified sources have been estimated using a linked watershed in-reservoir model. Coupling SWAT with WASP, AECOM modeled the flow of water and nutrients through the more immediate and relevant portion of the watershed. The model was calibrated with actual data, when available, and represents the processes at work in this system sufficiently well to be used for management evaluations (AECOM 2009).

The results of the modeling effort indicate that, under current conditions, discharges from the RWHTF and L/E are the largest contributors of phosphorus to the system, providing approximately 90% of the external load to Barr and 84% of the external load to Milton (Table 3.1). Other point sources contribute additional TP to the system, but the total quantity from these sources is relatively small when compared to the two largest dischargers. Similarly, external NPSs represent only a small fraction of the TP loading to the BMW, at <5% for Barr and <11% for Milton. The low external NPS component is related to the low precipitation in this area (<16 inches/yr), relatively flat terrain in much of the immediate watershed, and soil conditions, all of which limit runoff. Runoff may still be a significant source of water and nutrients at times of heavy precipitation.

Direct atmospheric inputs and direct groundwater in seepage to the reservoirs are not accounted for in this analysis. These are extremely minor sources of TP to these systems, and are not readily controllable. Precipitation is estimated by unpublished FRICO data to account for <4% of water inputs and would represent far less than that percentage in terms of nutrient loading. Seepage into the reservoirs is estimated at <3% of water inputs and the associated TP load would be a smaller percentage of the total load.

The information provided in Table 3.1 forms the basis for Phase I wasteload and load allocations discussed in Section 4.0.

Table 3.1 Loads to Barr and Milton
(Based on the SWAT-WASP Model)

Source	Discharge	Barr Lake			Milton Reservoir		
	Average Conc. (ug/L)	Load (kg/yr)	% of External Load	% of Total Load	Load (kg/yr)	% of External Load	% of Total Load
EXTERNAL LOAD							
Point Sources within Datashed							
Lochbuie WWTP[1,2]	3000	-		-	22	0.06%	0.06%
Hudson WWTP[1,2]	3000	-		-	29	0.08%	0.07%
Fort Lupton WWTP[1,2]	3000	-		-	494	1.3%	1.3%
Brighton WWTP[1,2]	3000	-		-	491	1.3%	1.3%
South Adams WWTP[1]	4537	-		-	1,102	3.0%	2.8%
RWHTF[1]	2750	-		-	28,529	77.8%	73.0%
Aurora WWTP[1]	172	-		-	28	0.08%	0.07%
Centennial WWTP	683	1,194	1.8%	1.7%	65	0.18%	0.17%
Pump Works	2750	26,075	39.3%	37.1%	54	0.15%	0.14%
Littleton and Englewood WWTP	2900	33,893	51.1%	48.2%	1,840	5.0%	4.7%
MS4 Regulated Areas	463-598	2,189	3.3%	3.1%	452	1.2%	1.2%
Point Source Total	-	**63,350**	**95.4%**	**90.0%**	**33,106**	**90.3%**	**84.7%**
Other Sources[3]							
Clear Creek[1]	218-371	-		-	919	2.5%	2.4%
Big Dry Creek[1]	1155-1320	-		-	2,301	6.3%	5.9%
Cherry Creek Reservoir	68-110	596	0.9%	0.8%	56	0.2%	0.1%
Bear Creek Reservoir	32-80	1,091	1.6%	1.6%	76	0.2%	0.2%
Chatfield Reservoir	31-42	1,338	2.0%	1.9%	122	0.3%	0.3%
All other subwatersheds[1]	1046	-			70	0.2%	0.2%
Other Source Total		**3,025**	**4.6%**	**4.3%**	**3,543**	**9.7%**	**9.1%**
External Load Total		**66,375**	**100.0%**		**36,649**	**100.0%**	
INTERNAL LOAD							
Benthic TP Load from Barr		4,000		5.7%	2,000		5.1%
Benthic TP Load from Milton[1]		-		-	419		1.1%
Total Load (all sources)		**70,375**		**100.0%**	**39,068**		**100.0%**

Notes: SWAT-WASP used for partitioning, but total loads were estimated as described in Section 3.0.
1. Source is downstream of Barr and therefore does not contribute TP Loads to the water body.
2. No effluent TP is monitored at the smaller WWTPs. Effluent TP concentrations are based on WWTP staff opinion and treatment expectations, not actual data.
3. Includes watershed and some point sources outside the datashed and additional non-point sources within the datashed

Internal loading is the subject of considerable uncertainty for Barr and Milton. The reservoir assessments performed by AMEC (2008a, 2008b) are largely annual mass balance efforts and require only small internal loads to balance the inputs and outputs. Those loads are consistent with the literature for typical release rates from anoxic sediments. However, phosphorus appears to be very dynamic in these reservoirs, with uptake by diatoms in the winter and spring resulting in high sedimentation of phosphorus and declining water column concentrations. TP values in the reservoirs often decrease in the late spring and then rise during the summer when external inputs are low, suggesting potentially substantial internal loading. However, diversions from the SPR can occur in summer and might account for the TP increases. There are very few submergent vascular plants in these reservoirs, so pumping of phosphorus from the sediments and release upon plant die off are not important phosphorus transfer mechanisms in these waterbodies. The remaining two mechanisms are chemical release of soluble phosphorus from sediments and resuspension of those sediments, potentially with dissociation of phosphorus from some particles. Both mechanisms represent likely phosphorus sources in these reservoirs, given very high sediment TP levels and declining water levels over the summer.

To make the model more accurately predict TP concentrations in Barr over the summer, a very high internal load was needed to counteract the settling observed in the spring. The resultant internal load represents almost 28% of the total load to Barr in the SWAT-WASP model for the two model calibration years, 2003 and 2004. It seems likely that the model may not adequately represent the phosphorus settling rate, which may decline during summer as a function of warmer water temperature and dominance by buoyant cyanobacteria. Some internal loading is still necessary to match predicted to actual TP concentrations, yet there is considerable uncertainty surrounding the internal load of TP to these reservoirs.

Adjusting internal loading is less effective at improving model predictions for Milton, and for the two calibration years used, one had a positive internal load and the other a negative internal load. It is not clear why Milton would process TP differently than Barr, but the pattern of water loading is different, with more summer inflow to Milton than to Barr, and this may account for some of the difference. Additionally, at high water column TP concentrations, release from sediments should be depressed, so with the high levels of TP in both reservoirs, high rates of release would not typically be expected. At the same time, with roughly half the incoming TP being retained by the reservoirs (AMEC 2008a, 2008b), the sediment TP pool will be very large. Not all of that sediment TP can become available, and data on the available fraction are very limited (unpublished data for 3 cores from Barr, 1 core from Milton, Steve Lundt).

From the limited data for Barr, biologically available phosphorus (the loosely sorbed and iron-bound fractions) in the upper 10 centimeters (cm) of sediment ranges from 100 to 400 milligrams per kilogram (mg/kg) with a solids content around 15%. If the upper 10 cm of sediment are active in possible phosphorus transfer to the water, and a specific gravity of sediment of 1.5 is assumed, the total available phosphorus for transfer under each square meter of sediment is between 225 and 900 mg. With about 371 hectares (ha) of area exposed to anoxic conditions, this would equate to a possible transfer of 835 to 3339 kg of TP each year. With so little data, this is highly speculative, but is even less than that 4037 kg per year (kg/yr) estimated by AMEC (2008a).

Application of a typical phosphorus release rate for phosphorus-rich anoxic sediments of 12 mg per square meter per day (mg/m^2/day) (Nurnberg 1984) for 100 days over 371 ha, a transfer of 4452 kg/yr is derived. This does not include any resuspension or release from oxic sediments, especially those exposed during summer drawdown, which could be significant. Overall, internal loading of TP within Barr does not appear to be a major source when compared with loading from the watershed at this time. However, a load on the order of 4000 kg/yr, assumed for further analysis, equates to a TP concentration of 75 micrograms per liter (µg/L), which is enough to support algal blooms even without any watershed inputs. This load (4,000 kg/yr) equates to approximately 5.7% of the total load in Barr lake (Table 3.1). Consequently, internal loading must be addressed in the Phased TMDL.

There are even fewer sediment phosphorus data available for Milton (a single sample). However, that sample contained <11 mg/kg of biologically available phosphorus in the upper 10 cm of the core, a very low value. If this is correct and representative, it would explain the apparent low internal loading in Milton. Aluminum and calcium levels appear elevated in these sediments, and may be inactivating phosphorus to a greater extent than in many lakes, limiting recycling into the water column. For further analysis, the internal load to Milton was set at 2,000 kg/yr, half the internal load to Barr.

More study is needed before the role of internal recycling can be properly characterized for these reservoirs. While current internal loading does not appear large relative to watershed inputs, there is a risk that watershed management controls alone will not yield the desired in-reservoir results unless internal loading is reduced simultaneously. However, internal loads will naturally decline over time, even without sediment management options such as alum treatment or dredging.

The exact magnitude of the TP load to Barr and Milton is also somewhat uncertain. The combined SWAT-WASP model appears to track inputs through the system reasonably well, and the model's partitioning of the simulated load among defined sources as a percentage of the total appears realistic. The actual load, however, is subject to substantial variability as a function of spatial and temporal differences in loads and processes in the SPR and canals while the load is being transported to each reservoir. The SWAT-WASP model was run for only two years. Although these two years appear to represent overall variability in this system, a longer simulation would be desirable (Ernst and Owens 2009).

Therefore, this Phased TMDL prescribes additional data collection to refine the combined SWAT-WASP models.

Section 4

Phased TMDL Technical Analysis

4.1 Data Set Description and Sensitivity Analysis

Data for modeling and analysis come from multiple sources which are detailed by AMEC (2008a, 2008b) and AECOM (2009). Water quality and flow data were accumulated in a database compiled by AMEC for the Association. This database has been augmented with existing data gathered by AECOM modelers from public sources (e.g., U.S. Geological Survey and National Oceanic and Atmospheric Administration online storage systems) and reported in the model report (AECOM 2009). While a sense of the history of the Barr-Milton system is useful in understanding how current conditions developed, data for TMDL development were mostly from the post-2002 period, when the current reservoir monitoring program was initiated.

The combined SWAT (watershed) and WASP (reservoir) model focused on the period of 2003-2004 to simulate this complex system, partition the load, and test possible management scenarios. Data were not available to extend the model analysis to more recent years at the time of the modeling exercise, but comparison to more recent data is possible, and data for the reservoirs through at least 2007 have been considered in evaluating variation in conditions.

Sensitivity analysis is the study of how a model's response can be apportioned to changes in model inputs and is recommended as the principal evaluation tool for characterizing the most and least important sources of uncertainty in environmental models. The SWAT/WASP models were developed, calibrated, and used to predict water quality responses to hypothetical reductions in phosphorus from the watershed. The sensitivity analysis showed that in-reservoir phosphorus and Chl are reduced the most when the three major POTWs (RWHTF, L/E, and SACWSD) significantly reduce their effluent phosphorus levels. The sensitivity analysis also showed that internal loading in both reservoirs needs to be addressed in order to achieve the desired changes in pH levels in Barr or Milton.

The sensitivity analysis also showed that the smaller WWTPs (Centennial, Sand Creek (Aurora), Brighton, Fort Lupton, Lochbuie, and Hudson) and non-point sources did not change the model outputs significantly, indicating that they do not play a major role in the phosphorus budget at this point. However, modeling also showed that once the three major point sources and the internal loading are reduced, controlling smaller sources will become much more important.

The sensitivity analysis also indicated that there is a point of diminishing returns when it comes to reducing effluent phosphorus from the three major WWTPs. A small in-reservoir phosphorus decrease after simulating a major reduction in phosphorus from these facilities indicated low sensitivity to the modeling output for in-reservoir phosphorus and Chl response levels. This lack of sensitivity is due to effects associated with internal loading.

The modeling report (AECOM 2009) has a more detailed explanation of the scenarios that were run to develop the sensitivity analysis.

4.2 Level of Loading Reduction Necessary

The analysis described in Section 2 determined that a summer maximum TP concentration in each reservoir of 100 µg/L should attain the pH standard. To evaluate needed load reductions, the SWAT-WASP model was run multiple times, using various combinations of external and internal loads. The model results indicate that a summer in-reservoir TP = 100 µg/L could be achieved in Barr with a 95-97% reduction in external load and a 91-93% reduction in internal load. Because Milton is affected by the condition of Barr, Milton will be improved slightly more than Barr at those same reductions. The model suggests that a TP concentration of 100 µg/L in Milton during summer could be achieved with a 90% reduction in internal load combined with a 95% reduction in external load, or with a 78% internal load reduction combined with a 97%

external load reduction The SWAT-WASP model used conservatively high estimates for external TP loading; thus, the model may overestimate actual loads and actual needed loading reduction may be somewhat less. As such, this approach is viewed as providing an implicit MOS within the Phased TMDL process. Because the 100 µg/L target represents a maximum, not an average concentration, such an MOS is desirable.

Smaller load reductions are necessary to achieve an annual in-reservoir TP concentration that is no greater than 100 µg/L. Higher TP levels can be sustained during winter and spring without frequent violation of the pH standard, but summer is the most problematic time for pH exceedances. While in-reservoir TP values greater than 100 µg/L might achieve pH attainment (AECOM 2009), the probability of consistent attainment year-round is low. Therefore, a TP target of 100 µg/L as a maximum, with associated averages of 40-60 ug/L (Barr Lake) and 46-69 ug/L (Milton Reservoir) is appropriate.

The annual means that result from a summer maximum TP concentration of 100 µg/L in each reservoir supply an additional MOS. Also, as discussed previously, one of the uncertainties associated with actual phosphorus loads to the reservoirs is the amount of water that is diverted to the reservoirs each year (e.g., the volume of effluent from any single POTW that reaches Barr or Milton will vary from year to year). Therefore, for implementation-related purposes (such as Colorado Discharge Permit System permitting) a concentration-based approach, rather than a strict load-based approach, is recommended for POTWs receiving a wasteload allocation for phosphorus. Under this regime, the phosphorus effluent limitation at POTWs receiving wasteload allocations under the TMDL would be set at 100 ug/L end-of-pipe at any hydraulic capacity (rated or existing) for the identified facilities (Tables 4.1 and 4.2), and for any new dischargers, and 1000 ug/L end-of-pipe at any hydraulic capacity for the identified facilities, at the appropriate time during implementation. In effect, the approach to implementing the POTWs wasteload allocations is volume-independent.

Because water is diverted from the SPR to Barr and Milton primarily during winter months, but summer months are the most problematic time for pH exceedances, it is appropriate for phosphorous effluent limits for POTWs with assigned wasteload allocations to be implemented as: (1) an annual average, and (2) a 30-day average not to exceed three (3) times the annual average..

4.3 Wasteload and Load Allocation Strategy

The wasteload allocation (WLA) and load allocation strategy for Barr is shown in Table 4.2. The WLA and load allocation strategy for Milton is shown in Table 4.3. WLAs are distributed between wastewater treatment facilities and permitted stormwater sources. The total WLA for Barr is 4023 kg/yr, while for Milton the WLA is 2075 kg/yr. Point source dischargers located outside of the Barr-Milton datashed for the AECOM (2009) study are not included in the WLAs. Instead, these sources are characterized as "background" for both Barr and Milton Reservoir and, at this time, are not given a specific allocation, as shown in Table 4.1 and Table 4.2.

From the data collected during Phase I of the Plan, there may be additional information that could better identify or clarify sources and loads. For instance, the current allocation strategy has identified load allocations for watersheds (e.g., Big Dry Creek) and for background sources (e.g., upstream reservoirs). Additional data collection and studies will allow the Association to better identify the multiple sources in the BMW that contribute to the loads allocated in Phase I such that these sources can be minimized, where feasible.

Table 4.1 Barr Lake Allocation Strategy.

Source of Phosphorus to Barr Lake	Current Load (kg/yr)	% of Total Current Load	Load Reduction Rationale	Target Load Reduction (%)	Target Load (kg/yr)	Target In-Lake Concentration (ug/L)
Wasteloads						
Burlington Pump Works	26,075	37.1%	Treatment upgrade: 2,800 ug/L to 100 µg/L	96.5%	913	100
Littleton-Englewood WWTP	33,893	48.2%	Treatment upgrade: 2,900 ug/L to 100 µg/L	96.5%	1,186	100
Centennial WWTP	1,194	1.7%	Treatment upgrade: 700 ug/L to 100 µg/L	85.5%	173	100
MS4 Regulated Areas	2,189	3.1%	Some activity over last decade, plus more BMPs	20.0%	1,751	100
Wasteload Total	**63,351**	**90.0%**		**93.6%**	**4,023**	**100**
Loads						
Upstream Background Loads	**3025**	4.3%	Targeted for a 75% reduction through in-canal treatment in the Burlington Ditch	75.0%	756	100
Benthic P Load from Barr	4,000	5.7%	In-lake treatment to inactivate P in upper 10 cm of sediment	75.0%	1,000	100
Load Total	**7,025**	**10.0%**		**75.0%**	**1,756**	**100**
Total Load (all sources)	**70,376**	**100.0%**	Calculated loading limit to achieve maximum target load of 5,900 kg/yr and target in-lake maximum concentration of 100 µg/L	**91.8%**	**5,779**	**100**

Note: For wasteload allocations, the long-term permit effluent limitations for total phosphorus of 100 ug/L as indicated in the table above will be implemented as an annual average plus a 30-day average not to exceed 3 times the annual average at any hydraulic capacity (rated or existing) for the identified wastewater treatment facilities. Interim effluent limitations of 1000 ug/L for the Burlington Pump Works, Littleton-Englewood WWTP, and Centennial WWTP will be implemented as described in Regulation No. 85.

Table 4.2 Milton Reservoir Allocation Strategy.

Source of Phosphorus to Milton Reservoir	Current Load (kg/yr)	% of Total Current Load	Load Reduction Rationale	Target Load Reduction (%)	Target Load (kg/yr)	Target In-Lake Concentration (ug/L)
Wasteloads						
Burlington Pump Works	54	0.1%	Treatment upgrade: 2,800 ug/L to 100 ug/L	96.3%	2	100
RWHTF	28,529	73.2%	Treatment upgrade: 2,800 ug/L to 100 ug/L	96.4%	1,027	100
Littleton-Englewood WWWTP	1,840	4.7%	Treatment upgrade: 2,900 ug/L to 100 ug/L	96.6%	63	100
Centennial WWTP	65	0.2%	Treatment upgrade: 700 ug/L to 100 ug/L	85.7%	9	100
South Adams WWTP	1,102	2.8%	Treatment upgrade: 4,500 ug/L to 1000 ug/L	78.0%	242	100
Fort Lupton WWTP	494	1.3%	Treatment upgrade: 3,000 ug/L (approximate) to 1000 ug/L	67.0%	163	100
Brighton WWTP	491	1.3%	Treatment upgrade: 3,000 ug/L (approximate) to 1000 ug/L	67.0%	162	100
Aurora WWTP	28	0.1%	Effluent TP currently at 200 ug/L; no action	0.0%	28	100
Hudson WWTP	29	0.1%	Treatment upgrade: 3,000 ug/L (approximate) to 1000 ug/L	67.0%	10	100
Lochbuie WWTP	22	0.1%	Treatment upgrade: 3,000 ug/L (approximate) to 1000 ug/L	67.0%	7	100
MS4 Regulated Areas	452	1.2%	Some activity over last decade, plus more BMPs	20.0%	362	100
Wasteload Total	**33,106**	**84.9%**		**93.7%**	**2,075**	**100**
Loads						
Upstream Background Loads	254	0.6%	Targeted for a 75% reduction through in-canal treatment in the Platte Valley Canal	75.0%	64	100
Benthic P from Barr	419	1.1%	Reduced 75% by internal loading controls associated with Barr treatment	75.0%	105	100
Benthic P from Milton	2,000	5.1%	Treatment to inactivate P in upper 10 cm of sediment	75.0%	500	100
Clear Creek	919	2.4%	Target 20% reduction	20.0%	735	100
Big Dry Creek	2,301	5.9%	Target 20% reduction	20.0%	1,840	100
Load Total	**5,893**	**15.1%**		**45.0%**	**3,244**	**100**
Total Load (all sources)	**38,998**	**100.0%**	Calculated loading limit to achieve maximum target load of 5,300 kg/yr and target in-lake maximum concentration of 100 ug/L	**86.4%**	**5,319**	**100**

Note: For wasteload allocations, the long-term permit effluent limitations for total phosphorus of 100 ug/L, as indicated in the table above, will be implemented as an annual average plus a 30-day average not to exceed 3 times the annual average at any hydraulic capacity (rated or existing) for the identified wastewater treatment facilities. Interim effluent limitations of 1000 ug/L for the Burlington Pump Works, RWHTF, Littleton-Englewood WWTP, and Centennial WWTP, as well as for other identified facilities subject to Regulation No. 85 and/or required to achieve long-term effluent limitations of 1000 ug/L, will be implemented as described in Regulation No. 85.

As mentioned in Section 4.2 above, for implementation purposes at the identified wastewater treatment facilities receiving wasteload allocations, TP effluent limits would not be more restrictive than 100 ug/L "end-of-pipe" for the larger facilities and any new dischargers, while for the remaining facilities TP effluent limits would be 1000 ug/L "end-of-pipe". This is appropriate because, although POTWs can control their effluent TP concentration, they do not have any control over the amount of water that is diverted and placed in these off-channel reservoirs. As such, under the allocation strategy, the most stringent POTW effluent limits are set at the targeted in-reservoir TP level needed to achieve compliance with the pH standard. As with any numeric effluent limitation, actual effluent concentrations will include a significant MOS that ensures permit compliance with that limitation, meaning that overall concentrations of phosphorus discharged from POTWs will be less than 100 ug/L.

Notwithstanding the discussion contained in the preceding paragraph, interim effluent limitations for the Centennial, Littleton-Englewood, and Robert W. Hite (including the Burlington Pump Works discharge location) wastewater treatment facilities shall be set at 1000 ug/L. This value is selected for the interim effluent limitations because this level of treatment is consistent with that identified in the Water Quality Control Commission Nutrients Management Control Regulation No. 85 (WQCC 2012) (promulgated June, 2012). The Division has chosen to retain the 100 ug/L treatment as the long-term effluent wasteload allocations for the referenced facilities as modeled projections for both reservoirs were predicated upon achieving that more stringent level of treatment. However, if additional data developed during the Phase I implementation activities described in the TMDL Implementation Plan support alternative WLAs, the Phase II TMDL will include documentation for such revised wasteload allocations.

Significant water quality improvements will occur once phosphorus reduction facilities are in place at the larger POTWs (Centennial, Littleton-Englewood, and Robert W.Hite (including the Burlington Pump Works discharge location) wastewater treatment facilities) and in MS4 regulated areas identified in the TMDL. It is therefore appropriate that these improvements be implemented as expeditiously as feasible. Accordingly, reductions at other POTWs with wasteload allocations will not be required until evaluations of water quality improvements based on the reductions from the larger POTWs and identified non-point sources have been completed and additional phosphorus reductions are deemed necessary to achieve the in-reservoir water quality goals. However, interim improvements at these POTWs may be required in order to comply with other state regulatory requirements, including Regulation 85 (WQCC 2012).

The phosphorus load reductions do not preclude POTWs from identifying and implementing phosphorus reduction opportunities within the datashed boundaries, e.g., through water quality trading, nonpoint source projects, or offsets that are approved by the Division.
Load allocations are assigned to several sources, primarily "background" loading from upstream watersheds and internal loading (re-suspension of phosphorus within the reservoirs). However, some point sources outside the datashed have been included in the allocation tables, e.g., both Clear Creek and Big Dry Creek have several wastewater treatment facilities that discharge to these sub-watersheds.

These sub-watersheds were treated as a single input for modeling activities to evaluate conditions and possible remediation scenarios. As such, more distant point sources included in the Clear Creek and Big Dry Creek loads may need to be accounted for separately during refinement of the Phased TMDL. Some of these WWTPs already have reduced TP effluent limitations, but these could potentially need to be reduced in the future. It is expected that such evaluations will take place following completion of the first TMDL phase.

4.4 Margin of Safety

Establishing an MOS is difficult in cases where loading is highly variable from year to year and there is a strong seasonal component to loading. Where variation is high, a statistical approach leads to larger MOS values; with the recommended load reductions for Barr and Milton are already so high (close to 90% overall for each reservoir), there is not much room to further reduce loading to support an explicit MOS. As such, common approaches involving an additional 10 to 20% loading reduction as an explicit MOS would be inappropriate in this case. Instead, the MOS for this Phased TMDL is implicit. A number of approaches for

determining an appropriate target TP were considered (AECOM 2009). Ultimately, this Phased TMDL defines a target TP level and associated wasteload and load allocations that are to achieve compliance with the pH standard in the reservoirs. Because of the uncertainties identified in development of this Phased TMDL, refinement of implementation approaches will be needed over time. This is not a short-term effort, and has major ramifications for implementation in terms of treatment improvements, timing, and costs. As additional data and information are developed through studies identified in the Plan, appropriate adjustments may be needed; however, the goal of attaining the pH standard of 9.0 s.u. through achieving the maximum 100 ug/L of TP in-reservoir target will remain the central implementation driver.

4.5 Seasonality and Variation in Assimilative Capacity

The seasonality of inputs to Barr and Milton is a significant factor in the condition of these water bodies. After a large decrease in volume over the course of the irrigation season, the reservoirs are refilled starting in November, usually with full status reached sometime in March. In some years, refill has continued into May, and water is added whenever possible to offset irrigation withdrawals, but water rights complicate both the timing and amount of available water.

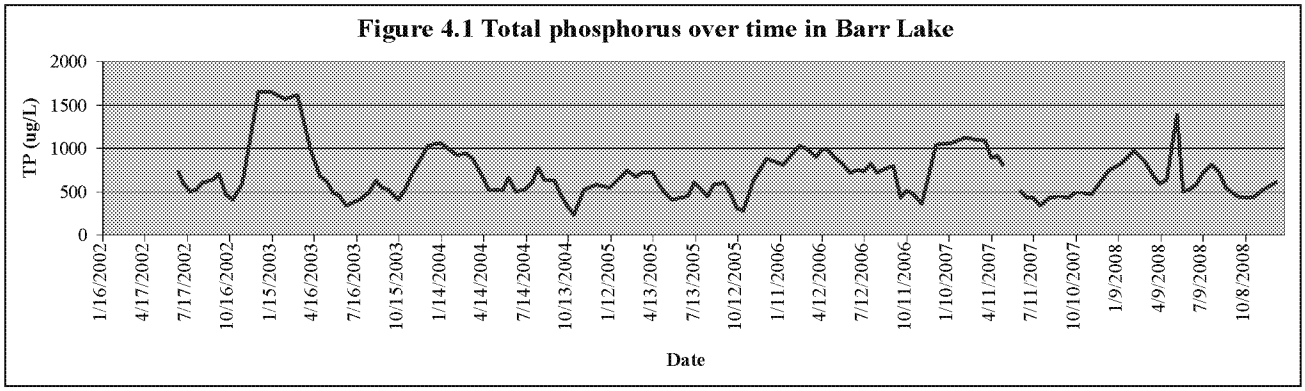
The uneven distribution of inflow and related loading to the reservoirs, summarized in Table 4.4, is an important factor in TMDL calculation. Long-term average loading can be predicted with some confidence, but confidence intervals increase with decreasing time scales. Given the expected temporal distribution of loads, deriving the maximum load that can be tolerated on any given day will be strongly dependent on the temporal distribution of river diversions to the reservoirs.

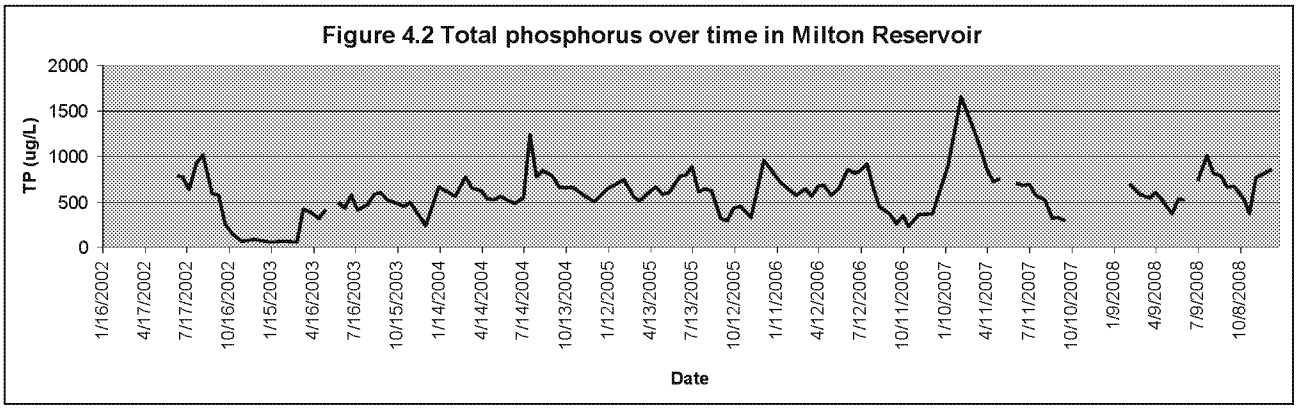
The withdrawal and refill cycle for the reservoirs results in a distinct pattern of TP concentrations, with values typically highest in winter and early spring, declining through spring into early summer, then fluctuating with internal processes and any additional diversions through the summer and into the fall. The internal processes include soluble phosphorus release from phosphorus-rich sediments under anoxic conditions and increased re-suspension of previously settled TP associated with particles through wind action as the reservoirs get shallower over the summer. The sediments are strongly oxygen demanding, but the extent and duration of anoxia varies with weather conditions and their effect on mixing.

Additionally, equilibrium chemistry is likely to alternately promote and hinder releases of soluble phosphorus from the sediments as water column phosphorus concentrations fluctuate. The contribution of resuspended particulate P to the available TP pool is unknown, and may change with changing loading. However, TP in both reservoirs has been observed to increase in late summer. These later-summer increases could be attributable to internal loading, and/or diversions from the SPR into the reservoir at low water volumes. The net result is an irregular oscillation of TP concentrations in the reservoirs during each year, with maxima typically observed in late winter and late summer, as shown in Figures 4.1 and 4.2.

Table 4.3 Assessment of Variability of Flows in Three Canals Delivering Loads to Barr and Milton Reservoir

Features of Flow Record (1968-2005)	Burlington-O'Brien Canal Into Barr	Platte Valley Canal at SPR Into Milton	Beebe Canal Into Milton
Period of record applied	1996-2005	1968-2005	1968-2005
Time Units	Days	Months	Months
Mean flow for all time units (cfs)	50.9	27.2	13.2
Time units with non-zero flow	2,388	193	432
% of time units with flow	65.4	44.7	100.0
Mean of time units with flow (cfs)	77.8	60.9	13.2
Standard deviation for time units with flow	77.5	47.9	5.4
Coefficient of variation for time units with flow	0.996	0.787	0.405





In addition to the seasonality in loading, there is a shift in the types of algae present that affects pH. The winter and spring phytoplankton assemblages are dominated by diatoms, while the summer and fall phytoplankton assemblages are dominated by cyanobacteria (AMEC 2008a, 2008b). The decline in TP over the course of the spring is likely related to uptake by diatoms followed by settling of those non-buoyant algae. Given slower metabolic rates at lower winter temperatures, incidences of high pH are less common in the winter. A greater biomass of diatom-dominated phytoplankton can be tolerated with fewer exceedances of the pH standard, as compared with summer conditions. In the summer, warmer temperatures favor cyanobacteria and greater metabolic activity overall.

Biomass can fluctuate substantially over space and time, as a function of grazing pressure by zooplankton (strongest in late spring and early summer), natural buoyancy by many types of cyanobacteria (leading to surface scums), wind (leading to downwind accumulations), and varying light (most notably self-shading during algal blooms). Exceedances of a pH of 9.0 S.U. can occur at any time in these reservoirs, but are more common in summer (by a ratio of 2:1 with all other seasons collectively). The pH appears more variable in summer (although the database is inadequate to determine spatial or temporal pH variation at any fine scale).

Barr and Milton appear to have higher assimilative capacities for TP loading during the winter. As most of the external loading occurs during winter, a higher load could be tolerated if processing within the reservoirs resulted in a lower level of available TP in the summer. Yet the loads in the winter have been high enough to maintain very high TP concentrations going into the summer, and the recycling of past loads by internal processes or smaller additional input pulses offset spring declines. The flushing rate is only about 1.3 to 1.4/year on average, so water and nutrient loads that enter in the spring have not been flushed through the reservoirs before summer. As a result, the phased TMDL must address winter and spring loads as well as summer loads. The combined SWAT-WASP model developed by AECOM for the reservoirs simulates these seasonal variations.

Section 5

Public Participation

The Association currently holds six public stakeholder meetings per year that involve discussion of topics concerning the BMW, including information about the Phased TMDL process. These meetings will continue to serve as informational sessions for the public about the Phased TMDL to support stakeholder involvement during this process. Stakeholder involvement activities to date have included presentations on the overall TMDL and implementation approach, discussion and review of studies and allocations, specific meetings with the upstream Control Regulation reservoir associations/authorities (Chatfield Watershed Authority, Cherry Creek Basin Water Quality Authority, Bear Creek Watershed Association), and outreach to smaller wastewater utilities that have WLAs under this Phased TMDL.

Additionally, the Association's Information and Education (I&E) Committee has been leading an effort to educate the public on water quality issues at Barr and Milton as well as progress on the TMDL. The I&E Committee has also been responsible for the majority of past efforts to educate the public regarding the work of the Association and encourage involvement in its activities. The I&E Committee increases awareness about the BMW and the Phased TMDL process through outreach campaigns, informational pamphlets, and a quarterly watershed newsletter. I&E committee members also provide representation at local and regional events and conferences, and help facilitate events at Barr, where information concerning Phased TMDL development and Association activities is disseminated to visitors.

Future I&E Committee outreach and public involvement efforts will include:

- Creating flyers and other materials with facts and information concerning the Phased TMDL process to disseminate at meetings.
- Creating press releases sent to key media outlets to increase awareness of the Phased TMDL process and dates for public meetings.
- Performing outreach via e-mail lists, watershed information outlets, and quarterly newsletter.

Following these meetings, the I&E Committee will develop an inventory of all public comments (including the outreach activity, the date of the activity, and key results/input) that will be made available on the Association website. A current version of the Phased TMDL and Plan will also be maintained on the Association website. The outreach plan will also incorporate methods to ensure that public participation goals are being met throughout the phased TMDL process.

COSPMS04 Barr Lake was included on Colorado's 303(d) list of impaired segments in 2002 and 2004 due to exceedances of the upper pH standard. In a subsequent South Platte Basin Rule-making Hearing, Milton Reservoir was included in COSPMS04. Milton Reservoir also was identified as impaired for pH. Therefore, both Barr Lake and Milton Reservoir have been included on Colorado's 303(d) list of impaired segments in 2006, 2008, 2010 and 2012. The development of the 303(d) list is a public process involving solicitation from the public of candidate waterbodies, open participation in the 303(d) Listing Methodology Workgroup that is periodically convened, and a public hearing before the Colorado Water Quality Control Commission. Public notice is provided concerning both the solicitation of impaired waterbodies and the public hearing.

The TMDL itself is the subject of an independent public process. This TMDL report was made available for public review and comment during a 30 day public notice period in May 2011, which was extended through August 15, 2011. Appendix A is a summary of the comments received during the public notice period and the Division's responses to those comments.

After the public notice period for the Phased Total Maximum Daily Load to Achieve pH Compliance in Barr Lake and Milton Reservoir, Colorado Report (BMW pH TMDL) and Total Maximum Daily Load Assessment (Addendum) Barr Lake and Milton Reservoir for Dissolved Oxygen Report (DO TMDL), the Water Quality Control Division (Division) prepared responses to comments and revised the reports accordingly. The

Division provided the revised reports with responses to comments to the Barr Milton Watershed Association (BMWA) in August 2012. The BMWA contacted Division management and requested additional meetings with the Division to continue revising language in the TMDL reports. The Division met with BMWA in October and November 2012. On November 14, 2012, the Division met with BMWA representatives to discuss revisions and additions to the BMW pH TMDL and Implementation Plan documents to address BMWA's concerns. Appendix A includes issues raised and the Division's responses.

The Division finalized the TMDL package and submitted the TMDL to EPA in May 2013.

Section 6

Monitoring Strategy

This information is contained in the Plan.

Section 7

Restoration Strategy

This information is contained in the Plan.

Section 8

Daily Loading Expression

Although a daily loading timescale is not often meaningful for ecological prediction or long-term watershed management of lakes or reservoirs, expression of the TMDL on a daily basis is required by law (US EPA 2006). Daily expression can be helpful when evaluating noncontinuous monitoring data.

This Phased TMDL presents daily pollutant loads of TP in addition to the annual load, and there is flexibility in how the daily loads may be expressed for the purpose of tracking compliance (US EPA 2006). Options are presented in a manual entitled *Options for Expressing Daily Loads in TMDLs* (US EPA 2007), and an approach appropriate to the loading scenarios for Barr and Milton was chosen.

The Barr and Milton dataset and associated empirical model necessitates a statistical estimation of allowable maximum daily load because long periods of continuous simulation data and extensive flow and loading data are not available. The US EPA (2007) provides such an approach. The following expression assumes that loading data are normally distributed and is based on a long-term mean target daily load and an estimation of the expected variability in loading.

$$MDL = \mu + Z_p * CV * \mu$$

Where:
MDL = maximum daily limit
μ = average daily load
Z_p = z-statistic of the probability of occurrence
CV= coefficient of variation of the load

Because the timing and mechanisms of external and internal loading are so different, calculation of the Phased TMDL on a daily basis is divided into external and internal components for these reservoirs.

8.1 Wasteload

There are not enough reliable data to accurately estimate the variability in actual loads to the reservoirs. Alternatives include: (1) Using loading data for the two major WWTP discharges, which represent a large portion of the load to each reservoir, and (2) using flow data provided by FRICO, which represent water inputs but do not reflect any variability in the TP concentration in those water inputs. The Coefficient of variation (CV) of 112 daily loads calculated from data for the RWHTF is 0.36. The CV of 135 daily loads calculated from data for L/E is 0.06. These are relatively low CV values, and will result in a low daily load using the above formula. The number of loading values is not particularly high, given limited testing for TP in the discharge, increasing potential error. Additionally, the loads from these two WWTPs do not all go to the reservoirs. As such, flow is probably a more important predictor of variability in these cases.

Analysis of the flow data for the three canals delivering water to the two reservoirs (Table 4.4) indicates that variation in water delivery will be far greater than variation in WWTP loading to the SPR, and that using the wastewater treatment plant loads as an indication of variability in loading to the reservoirs will underestimate that variability. Using the available data for flow and TP concentration in the canals on coincident dates to derive a loading distribution would improve the assessment, but the available data are too limited to generate a reliable distribution for each canal. Consequently, variation in flows to the reservoirs, with many observations from which to

derive key statistics, was used as a surrogate for loading in the derivation of a TMDL. The CV values in Table 4.4 can be used to derive the maximum allowable daily load to each of the reservoirs from wasteload sources, using the assumption that the TP concentration will not vary substantially among dates. Slightly higher variability would be expected if TP concentration could be incorporated into the analysis to generate actual loads for enough dates to generate a reliable distribution. A 95% probability level of occurrence (Z_p = 1.64) was applied. The CV applied to Barr loading is the CV for the Burlington-O'Brian Canal (0.996), while the CV for Milton loading is derived as the weighted mean of the CV values for the Platte Valley and Beebe Canals [(60.9 x 0.787 + 13.2 x 0. 405)/74.1 = 0.719]. The Platte Valley Canal and Burlington-O'Brian Canal values are based on monthly data, as the daily data were considered unreliable, and will underestimate actual variability as a consequence.

Loading to Barr and Milton varies over the days of the year, with most inputs occurring over a short time frame, as evidenced by the Burlington-O'Brian Canal data (Table 4.4). The measured monthly variability is not as great as the expected daily variability for the Platte Valley Canal and Burlington-O'Brian Canal, but is still substantial, based on the FRICO flow data summarized in Table 4.4. Flow into Barr occurs in just under 2/3 of the days of the year on average. Flow into Milton via the Platte Valley Canal occurs in only about 45% of the months for a nearly 40-year period of record, while flow from Beebe Canal occurs in all months.

However, the Platte Valley Canal inputs represent 67% of the flow (over twice the Burlington O'Brian Canal flow on average), and from the available TP data, water entering Milton from the Platte Valley Canal has over twice the TP concentration as water in the Burlington-O'Brian Canal, on average. This means that about 81% of the external load to Milton enters through the Platte Valley Canal. Thus, the loading distribution should be based on times of active inputs from the Platte Valley Canal.

Based on the factors described above, the average daily wasteload for Barr should be calculated by dividing the annual wasteload allocation by the portion of time that the Burlington-O'Brian Canal flows into Barr (0.67, or 239 days). The average daily wasteload for Milton should be calculated by dividing the annual wasteload allocation by the portion of time that the Platte Valley Canal flows into Milton (0.45, or 164 days). The average allowable daily wasteload to Barr during the effective loading period becomes 9.5 kg/day (2272 kg/239 days) and the maximum daily wasteload would be calculated as 25.0 kg/day. The average daily wasteload to Milton is 10.4kg/day (1713 kg/164 days) and the maximum daily wasteload is 22.8 kg/day.

8.2 Load

The load allocation should be calculated separately for NPSs from the watershed and internal loading, since these will be addressed very differently in phased TMDL implementation. The values can be added together for purposes of meeting reporting requirements, but separation will be helpful in management planning.

8.2.1 Non-Point Source Load

The allowable NPS load to Barr from external sources is estimated at 756 kg/yr, while that for Milton is estimated at 2,639 kg/yr. The mode of delivery is through the canals, so the statistics applied to wasteloads apply to NPS loads as well. Applying this approach, the allowable daily average NPS load to Barr is 3.2 kg/day and the maximum daily load is 8.3 kg/day. For Milton, the allowable daily average NPS load is 6.7 kg/day and the maximum daily load is 10.4 kg/day.

8.2.2 Internal Load

The acceptable internal loading to achieve pH compliance is estimated at an average of 1000 kg/yr for Barr, but most of this internal loading occurs during the summer. The analysis presented by AMEC (2008a) suggests an internal loading period of 60 days, but internal loading could be significant for up to 120 days (June – September). For this analysis, a 90-day internal loading period is assumed. The average daily internal load to Barr during the expected loading period is therefore 11.1 kg/day (1000 kg/90 days). The CV for summer epilimnetic TP data provided by the Metro District since 2002 for Barr is 0.236, so the maximum daily allowable internal load for Barr is calculated as 15.4 kg/day by the formula applied to the external load.

For Milton, applying the same statistical approach used for the Barr internal load, the CV for summer epilimnetic TP in Milton is 0.337 and the daily maximum allowable internal load to Milton would be the estimated daily load times 1.55. With an estimated Milton internal daily load of 6.7 kg/day (605 kg/90 days), the maximum daily allowable internal load to Milton would be 10.4 kg/day.

8.3 Total Maximum Daily Load Summary

While a daily expression of the phased TMDL is needed and useful, knowing the allowable load over multiple temporal and spatial scales is needed for implementation planning. Different measures will be required to reduce external and internal loads, and point and NPSs will also require different management approaches.

Table 8.1 Summary of Allowable Loads for Barr and Milton.

	Barr Lake				Milton Reservoir			
Source	Existing Load (kg/yr)	Target Load (kg/yr)	Daily Mean Target Load (kg/day)	Total Max. Daily Load (kg/day)	Existing Load (kg/yr)	Target Load (kg/yr)	Daily Mean Target Load (kg/day)	Total Max. Daily Load (kg/day)
Wasteloads								
Permitted WWTP discharges	61162	2272	9.5	25.0	32654	1713	10.4	22.8
Permitted MS4 stormwater systems	2189	1751	7.3	19.3	452	362	2.2	4.8
Loads								
Nonpoint source inputs	3025	756	3.2	8.3	3474	2639	16.1	35.1
Internal loading from reservoirs	4000	1000	11.1	15.4	2419	605	6.7	10.4
Total	70376	5779	31.1	68.1	38999	5319	35.5	73.1
External Load only	66376	4779	20.0	52.7	36580	4714	28.8	62.7

Note: For wasteload allocations, the most restrictive permit effluent limitations for total phosphorus would be 100 ug/L implemented as an annual average plus a 30-day average not to exceed 3 times the annual average at any hydraulic capacity (rated or existing) for the identified wastewater treatment facilities.

Based on the analysis conducted to develop this Phased TMDL, the maximum daily allowable external TP loads to Barr and Milton are 33.4 kg and 57.8 kg, respectively. Over the course of the year, external daily loads when there is significant inflow should average 12.7 kg to Barr and 26.5 kg to Milton, while the annual external load should be 4779 kg to Barr and 4714 kg to Milton.

The internal load in Barr should average 1000 kg/yr and 11.1 kg/day, with a daily maximum of 15.4 kg/day. For Milton, the corresponding values are averages of 605 kg/yr and 6.7 kg/day with a daily maximum of 10.4 kg/day. Nearly all of the internal loading in both reservoirs occurs during the summer. The sum of the external and internal TMDL components is not a meaningful value, given different timeframes for these separate inputs.

An initial estimate of allowable inflow concentration can be generated using the external Phased TMDL and the average flows for the canals. For the Burlington-O'Brian Canal inflow to Barr, with an average flow of 77.8 cfs on days when there is flow, the Phased TMDL of 33.4 kg/day translates into a maximum inflow TP concentration of 175 µg/L, although the daily concentration should average 67 µg/L over the course of the year. This is a major decline from a current maximum TP level in the Burlington-O'Brian Canal of about 2900 µg/L and an average value on the order of 1250 µg/L.

For Milton, the inflows from the Platte Valley Canal and the Beebe Canal total 74.1 cfs as an average flow on days when there is flow in the Platte Valley Canal. The WLA of 57.8 kg/day equates to a maximum inflow TP concentration of 319 µg/L, with a daily average concentration of 146 µg/L entering Milton (as a weighted average of PVC and BC inputs). These values are much lower than the current maximum input concentrations of more than 1500 µg/L and average concentrations in excess of 500 µg/L in the canals discharging to Milton.

For the internal load, assuming a contributory area of roughly 371 ha (3.7 million square meters), the average and maximum TP release rates (from re-solubilization and re-suspension) would be about 3 and 4 mg/m^2/day for Barr and 2 and 3 mg/m^2/day for Milton, respectively. These are low but achievable values with available in-reservoir techniques.

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The Barr Lake and Milton Reservoir pH TMDL report and the Barr Lake and Milton Reservoir DO TMDL report were made available for public review and comment during a 30 day public notice period in May 2011, which was extended through August 15, 2011. A summary of the comments received during the public notice period and the Division's responses to those comments are provided below.

The Division received comments from Centennial Water and Sanitation District on June 29, 2011.

Centennial Comment 1:

WQCD's changes eliminate language that calls into question the relationships between pH, chla, TP and makes connections more concrete, thus justifying the specific TP controls. The intent appears to be designed to eliminate statements of "uncertainty" regarding the relationship to justify position that TP reductions will most certainly improve water quality in Barr and Milton. That relationship is not clear and it was the intent of the Phased Implementation Plan to clarify that fact.

***Division Response**: This TMDL is written as a phased TMDL because the uncertainty in the causal-response relationships. To be clear, there is no doubt that relationships exist. The WQCD, EPA, as well as the scientific community, in general, accept that the causal-response relationships exist between total phosphorus and chlorophyll and between chlorophyll and pH, although these are very difficult to quantify. However, phased TMDLs must be written to attain standards. The Barr-Milton TMDL target is considered quite high for a total phosphorus target. In developing the TMDL targets, several approaches were explored and are described in "Watershed and Lake Modeling for a TMDL Evaluation of Barr Lake and Milton Reservoir", 2009, and summarized in the TMDL report. Several empirical models resulted in a TP target of 50 ug/L . WQCD deleted language that suggested that the target might not attain the standard because this would suggest that the target was not stringent enough. The Division's revisions did not eliminate the uncertainty of the relationships in the variables in the TMDL. The TMDL report adequately acknowledges that such uncertainty exists. The phased TMDL approach is intended for use in situations where uncertainty exists or is acknowledged but unquantified.*

Centennial Comment 2 :

Centennial views changes on Page 4-2 and Tables 4.1 and 4.2 as substantial. Their understanding was that if POTWs were able to demonstrate compliance with the 100 ug/L target at the point of diversion off the South Platte River, they would have met their obligation for reducing load on the Lake. Centennial states that the Division's revisions effectively eliminate any opportunity for consideration of dilution or other sources in the intervening reaches of the receiving waters between Centennial and Barr Lake and Milton Reservoir, and that the revisions may also preclude the possibility of effluent trading with another facility. It appears to Centennial that the revisions are inconsistent with how water quality standards are generally implemented in permits and that they tie a permit writer's hands by dictating discharge permit limitations that may not be necessary or appropriate. Centennial cited Regulation 61.8(2)(b)(i):

"Effluent limitations designed to meet water quality standards shall be based on application of appropriate physical, chemical, and biological factors reasonably necessary to achieve the levels of protection required by the standards. Such determination shall be made on a case-by-case basis." Centennial also cited Regulation 61.8(2)(b)(iv): "Utilizing best engineering judgment, where subsection (b) is applicable, the Division will use a mass-balance analysis to define the effluent limitations for discharges to surface waters such that the combined concentrations of pollutants contributed by the discharger and the receiving waters upstream from the point of discharge do not exceed the water quality standards for the receiving waters, downstream of any mixing zone established by the Division for each pollutant."

Centennial requests that the Division restore the original language because they state the Division did not provide a rationale for why the revisions were necessary or appropriate.

***Division Response**: WQCD's determination is that WLAs for Barr Lake (note that the Milton Reservoir WLA for Centennial is less stringent, and therefore is not limiting) in the TMDL tables were modeled with effluent limits set at 100 ug/L for Centennial, MWRD, and Littleton-Englewood, and 1000 ug/L for all other facilities. Although this was not specified in the TMDL document sent to WQCD in December 2010, the TMDL tables did specify an in-lake target of 100 ug/L for all facilities, which suggests that this is also the effluent concentration for all facillities.*

However, the Division did not set a 100 ug/L effluent limit by applying the in-lake target to facilities as an end-of-pipe limit. Rather, the Division referred to the modeling report prepared by BMWA's consultant, AECOM entitled "Watershed and Lake Modeling for a TMDL Evaluation of Barr Lake and Milton Reservoir", 2009 report. The modeling report describes scenarios modeled to attain the in-lake total phosphorus target of 100 ug/L. The scenarios evaluated attainment of the in-lake target by testing different effluent concentrations, as well as nonpoint source reductions. The effluent concentration of 100 ug/L TP for MWRD, Littleton-Englewood, and Centennial, were used in the model, as well as the other reductions identified in the tables, demonstrated attainment of the target. The WLAs in kilograms were based on effluent concentrations of 100 ug/L for the three facilities identified.

While the WLA in kilograms in the TMDL tables were consistent with the tables WQCD had agreed to earlier in 2010 (July 2010), WQCD staff had been encouraging a concentration-based approach for this TMDL. To write the TMDL as a concentration-based TMDL, the Division determined that effluent concentrations should be stated in the TMDL, and used the effluent concentrations in the TMDL model. The Division recommends that the effluent concentration be at end-of-pipe (as used in the TMDL model) at any flow regime in the receiving water.

*The TMDL does not preclude effluent trading with another facility. It is expected that trading would be developed during implementation. Refer to the **Colorado Pollutant Trading Policy** for guidance. Any trading program would be incorporate EPA's Reasonable Assurance requirements.*

Centennial Comment 3 :

The removal of table footnote "30-day-average not to exceed three (3) times the annual average" further restricts flexibility in operations.

***Division Response**: To address this comment, the WQCD TMDL program consulted the WQCD Permits Unit regarding the BMW's original draft that included a 30-day average as well as the annual average. The 30-day average was 3X the annual average. Based on this consultation, the original 30-day average will be used in the TMDL. Appropriate revisions have been made to the TMDL document.*

Centennial Comment 4:

Centennial requests their comments be considered in the context of the Centennial location in the system. Centennial is 1.7% of the load on Barr Lake and 0.2% of the Milton Reservoir load, and is 35+ miles from the diversion from the South Platte River. CWSD has completed a study on the existing WWTP that indicates costs ranging from $21.8M to $46.6M to comply with a 100 ug/L end-or-pipe limit, with no increase in plant capacity. Yet it is not at all clear that these costs have a reasonable relationship to potential environmental benefits of water quality improvements in Barr Lake or Milton Reservoir.

***Division Response**: The WLAs identified in the TMDL tables 4.1 and 4.2 are based on modeled scenarios. These are described in the modeling report prepared by BMWA's consultant, AECOM entitled "Watershed and Lake Modeling for a TMDL Evaluation of Barr Lake and Milton Reservoir", 2009 report.*

The cost associated with attainment of an assigned standard is a legitimate consideration, and the Basic Standards and Methodologies for Surface Water, 5CCR 1002-31, include provisions which enable parties to bring such arguments before the WQCC within the context of the standards setting process. The WQCC is the rulemaking body charged with determining the appropriate uses and standards for all waters of the state. This occurs through a public, environmental policy setting process. The TMDL must address the assigned water quality standard, or in this case, the surrogate water quality target that drives attainment of the assigned water quality standard for pH in Barr Lake and Milton Reservoir. The TMDL process is not a vehicle for consideration of whether the assigned uses and/or standards are appropriate for a given waterbody. Economic and social impacts may be considered by the Water Quality Control Commission with respect to an alternate Water Quality Standard should such hearing be requested and determined to be appropriate.

Centennial Comment 5:

It has not been reliably demonstrated that the proposed limitations will overcome current and past nutrient loading and in-lake accumulation incurred by choice of the Barr Lake operation.

Division Response: The TMDL is written as a phased TMDL in order to allow for refinement of targets. If the proposed limits are not low enough to attain the TMDL targets, then adjustments can be made in subsequent revisions to the phased TMDL.

Regarding the accumulation of internal phosphorus load, recognize that internal load is legacy external load, and therefore proportionately due to point sources. It is widely accepted, limnologically, that with adequate watershed reductions, internal load will dissipate over time. The TMDL should be set low enough so that internal load is not continually regenerated. Furthermore, internal load reductions are included as part of the TMDL.

Centennial Comment 6:

The Division's changes do not appear to respect the process established by the BMWA for the development of the pH TMDL. Centennial is disappointed that the Division did not discuss its subsequent revisions with BMWA prior to sending the TMDL, including the revisions that it made, to public notice. It is our understanding that the revisions were based on discussions with EPA Region 8 staff outside of the stakeholder process established by BMWA. Centennial requests for the TMDL for pH in the BMW be restored to the version that was submitted to the Division in December which, notwithstanding significant uncertainties in the scientific conclusions, they reluctantly supported.

Division Response: *The Division and EPA participated in and offered comments on several iterations of the TMDL report. The Division believes it was clear in communicating to the group that once the final draft was submitted to the Division, the processs would be that changes could, and would likely, be made to the draft in order to make the TMDL approvable by EPA*

Although the Division had found most of the TMDL acceptable in earlier iterations, some of those approved parts had been changed in the final draft received by the Division in December 2010. Therefore, the changes the Division made to the TMDL report were based on what was submitted in December. As explained in several meetings since the public notice period began, the Division was encouraging the development of a concentration-based TMDL, which had several advantages over a traditional TMDL. As such, the TMDL must have effluent concentrations explicitly stated. The effluent limits of 100 ug/L for three larger WWTFs and 1000 ug/l for the other WWTFs are the end-of-pipe concentrations used in the TMDL model. The draft the Division received from BMWA did not include effluent limits, so the Division revised the draft to include these.

For phased TMDLs, concentration-based WLAs allow for more flexibility than a traditional load-based approach because it allows for changes in the volume of a plant's discharge without correspondingly changing the allowed effluent concentrations and allows for potential new discharges. (Please refer to response to MWRD Comment 3 for additional explanation.)

South Adams County Water and Sanitation District

The Division received comments from South Adams County Water and Sanitation District dated June 23, 2011.

South Adams County Water and Sanitation District's (SACWSD) comments discussed the economic implications of treatment plant upgrades required to meet the TMDL that was public noticed by the Division. Specifically, they state that the original assumptions of the TMDL had been that the smaller facilities would treat to 1000 ug/L total phosphorus, rather than the 100 ug/L effluent concentration for all facilities that resulted from the Division's changes to the TMDL report.

Division Response: The draft TMDL submitted to the Division did not specify that the effluent concentrations for the smaller plants would be 1000 ug/L. That detail, although in an earlier draft, had been deleted from the document that was submitted to the Division as the final draft. The Division had agreed with the approach incorporated in the earlier draft of the TMDL.

The Division did not intend all facilities to treat to 100 ug/L, and agrees that smaller plants should have to treat to 1000 ug/L. The TMDL has been amended so as to be explicit in this regard.

Town of Lochbuie

The Division received comments from the Town of Lochbuie dated July 7, 2011. Issues and concerns focus on TMDL Process and Economics.

Lochbuie objects to WQCD's changes. They specifically oppose the assignment of specific phosphorus discharge concentration limits to all point sources, particularly the Lochbuie wastewater treatment plant.

Although they clarify that the underlying modeling used 1000 ug/L for the smaller facilities, they state that was for modeling only, and they want to keep the flexibility to achieve their annual target load through other forms of treatment rather than effluent limits: ex: in-ditch treatment, groundwater recharge or other. Lochbuie's comments also discuss economic concerns. They conclude by requesting that the text of the TMDL be revised to delete all references to the 100 ug/L discharge standard for Lochbuie, to modify the tables to delete that reference in the footnote, and to make other changes to the TMDL to allow flexibility to Lochbuie and other wastewater treatment plant operators to achieve their waste load allocations and reductions.

Division Response: Lochbuie seems to favor a traditional load-based TMDL, rather than the concentration-based approach the Division had recommended. The Division would like to clarify to the Town of Lochbuie that a TMDL does result in effluent limits in the facility's permits, and as Lochbuie acknowledged in their comments, the TMDL model used the 100 ug/L and 1000 ug/L TP concentrations for the WWTFs to attain the TMDL target. Therefore, it is appropriate for these concentrations to be applied as effluent limits. Furthermore, the

phosphorus was modeled conservatively, so this assumes that all the phosphorus eventually is transported to the reservoir.

The Division did not intend to make all facilities have effluent concentrations of 100 ug/L, but was trying to clarify what the BMWA had provided in the draft TMDL. As noted in responses to comments (Centennial, MWRD, South Adams County Water and Sanitation District, Aurora, BMWA) the TMDL has been revised to identify facility-specific WLAs as either 100 ug/L or 1000 ug/L.

City of Fort Lupton.

The Division received comments from the City of Fort Lupton (FtL), dated June 27, 2011. FtL's comments are related to Technical, Permit, Standards and TMDL Process issues.

Fort Lupton is not in agreement with any process for establishing Total Maximum Daily Limit (TMDL) standards for total phosphorus, pH or Dissolved Oxygen for the Barr-Milton watershed at this time.

The process appears to be very complicated and the published information is not in a form that they can pass on to their City Council members and wastewater customers. They believe there are many questions that need to be answered:

1. What are the costs and benefits for meeting the proposed TMDL standards?
2. Will the proposed TMDL standards be incorporated into their wastewater discharge permit and when will this process occur?
3. Will the CDPHE establish the same TMDL standards as part of the proposed nutrient regulations that are currently under review?

They summarize by stating that they cannot support any proposed TMDL standards at this time because they do not understand future consequences to their wastewater rate customers and the costs and benefits of establishing such standards.

Division Response: The cost associated with attainment of an assigned standard is a legitimate consideration, and the Basic Standards and Methodologies for Surface Water, 5CCR 1002-31, include provisions which enable parties to bring such arguments before the WQCC within the context of the standards setting process. The WQCC is the rulemaking body charged with determining the appropriate uses and standards for all waters of the state. This occurs through a public, environmental policy setting process. The TMDL must address the assigned water quality standard, or in this case, the surrogate water quality target (total phosphorus) that drives attainment of the assigned water quality standard for pH in Barr Lake and Milton Reservoir. For clarification, a Total Maximum Daily Load (TMDL) is the amount of a pollutant that will allow attainment of water quality standard. The TMDL, in itself, does not establish a standard. Establishing a standard is a separate process from a TMDL. The TMDL process is not a vehicle for consideration of whether the assigned uses and/or standards are appropriate for a given waterbody. To have economic impacts of the pH standard considered, Fort Lupton would have

to petition the Water Quality Control Commission with respect to an alternate Water Quality Standard. It would be up to the Commission to determine if the information provided warrants setting a hearing to consider revision to the pH standard.

*Barr Lake and Milton Reservoir have WQCC-promulgated numeric water quality standards for pH and dissolved oxygen, as well as other standards. The Division has determined that both reservoirs are impaired for pH and dissolved oxygen. The original 303(d) listed impairment was for pH. The DO impairment was added to the 303(d) list for Milton Reservoir in 2010 and for Barr Lake in 2012. Because impairments of pH and dissolved oxygen are attributed to eutrophication (nutrient enrichment), this TMDL sets a total phosphorus target that is intended to result in attainment of the underlying pH and dissolved oxygen standards. The TMDL process identifies the target pollutant and the appropriate level of that pollutant to attain the underlying standard. The TMDL process does not evaluate cost-benefits of the TMDL. This is a consideration relative to the WQCC standards promulgation process (*C.R.S. §25-8-102(5)*).*

The TMDL target load is allocated to point and nonpoint sources in the watershed. The allocations for the point sources typically are incorporated into a facilities discharge permit when the permit is up for renewal.

The Nutrient Criteria development process is separate from the TMDL process.

Chatfield Watershed Authority

The Chatfield Watershed Authority (CWA) submitted comments on the Barr Milton pH and DO TMDLs on June 30, 2011. CWA's comments focus on technical and process issues, with some underlying economic and legal concerns.

CWA Comment 1

CWA questions legal and technical bases for including Chatfield Reservoir in the proposed TMDL since the reservoir outflows are well below (21 ug/L) the BMW TMDL target of 100 ug/L. CWA submitted a figure illustrating Chatfield Reservoir outflow data to demonstrate that the outflows are well below the Barr Milton TMDL target of 100 ug/L, and state that Chatfield Reservoir provides a benefit and assimilative capacity for the Barr-Milton system. CWA concludes that there is no factual, legal or policy basis to include Chatfield Reservoir in the TMDL or to require phosphorus load reductions from Chatfield Reservoir. CWA requests to be omitted from TMDL and from Tables 3.1, 4.1 and 4.2 in the TMDL.

Division Response: All loads are identified in a TMDL, and the Chatfield Reservoir release (and releases from the other upstream reservoirs) is incorporated into the background load. TMDLs must identify sources, and background loads. However, there is no permit requirement for the reduction of load allocations, and since Chatfield Reservoir, Cherry Creek Reservoir and Bear Creek Reservoir fall under the Load Allocation, there are no requirements for permit-based

controls or reductions in the Chatfield Basin or the other reservoir basins as a result of the BMW TMDL.

The Division believes that adequate efforts are being made in the Chatfield Basin to address phosphorus control (Chatfield Reservoir Control Regulation, 5 CCR 1002-73), and does not anticipate any further regulatory requirements beyond what is required by the Chatfield Control Regulation. Phosphorus controls required by the Chatfield Basin Control Regulation are adequate to control phosphorus downstream, over time.

CWA Comment 3

CWA questions whether the TMDL adequately addresses Fate and Transport of phosphorus throughout the watershed.

*Division Response: The Division believes, for this phase of the TMDL, that the model adequately captures fate and transport of phosphorus throughout the watershed. Information detailing the fate and transport is included in the Barr-Milton modeling report, (*AECOM. 2009. *Watershed and Lake Modeling for a TMDL Evaluation of Barr Lake and Milton Reservoir*. AECOM Global Environment, Willington, CT).

CWA Comment 4

CWA believes a Load Allocation (LA) for agricultural runoff is needed. CWA wants the LAs to quantify agricultural return flows and LAs to be assigned to agricultural lands, ditch companies and irrigations companies. "Since a significant portion of this agricultural flow is not purely "exempt", the operator should bear some responsibility for reductions of these loads.

Division Response: Agricultural runoff is a component of the nonpoint source runoff and is adequately characterized in the TMDL. Nonpoint sources are not significant sources of the phosphorus loading, relative to the existing loads to the Barr Lake and Milton Reservoir system.

CWA Comment 5

CWA states that total phosphorus may not, based on science, be the appropriate TMDL parameter. Their rationale is that there is a poor correlation between pH and total phosphorus and between DO and total phosphorus.

Division Response: The Division disagrees. Although the relationship between TP and pH may not be entirely quantified, the relationship does exist, and is well-accepted in the scientific community. A phased approach in the TMDL is being used because of the uncertainties in the quantification of the relationship between TP and pH.

CWA Comment 6

CWA states that the Implementation Plan is erroneous in suggesting that background sources are a responsible party that should pay for proposed in-canal treatment. They believe that this assertion is misplaced since the historical use for Barr Lake and Milton Reservoir has been for agricultural purposes and the water quality conditions in the reservoirs

Division Response: Barr Lake and Milton Reservoir are classified for other uses in addition to agricultural uses. Actually, the standards for which Barr Lake and Milton Reservoir are listed are for pH and DO, which are aquatic life standards. As such, the TMDL is written to attain those standards and associated uses. The TMDL identifies sources, associated loads from those sources and identifies required reductions from those sources. The background sources are identified as loads, not wasteloads, and the Implementation Plan does not identify a responsible party for the reductions to the loads. In section 4.2 of the Implementation Plan, In-canal treatment is identified as an option for adaptive management approaches that will be analyzed once the TMDL is approved. There is no discussion of costs or responsible parties. In-canal treatment options also are discussed in Section 5.2.6 with regard to feasibility studies, but again, the costs and responsible parties are not discussed.

CWA Comment 7

CWA does not believe the Barr Milton pH and DO TMDLs are ready for adoption and requests that the TMDLs be re-evaluated.

Division Response: The Division disagrees, and would note that the TMDL development process was initiated in 2005 (a §319, Non Point Source grant was awarded in 2005 to fund development of the loading model). The draft TMDLs have been developed through an extensive public process through which considerable stakeholder input has been solicited and evaluated. Further, the Division notes that the TMDLs themselves incorporate a phased approach. The initial phase will involve reductions in phosphorus loading from the major contributors (of which Chatfield is not) coupled with ongoing monitoring intended to evaluate the results of those reductions. The development of the second phase TMDLs will include additional evaluation as well as additional opportunities for stakeholder input. The Division does not believe further delay with respect to submittal, approval and implementation of the Phase I TMDL is appropriate.

City of Brighton

The Division received comments from the City of Brighton dated June 29, 2011. Brighton submitted comments for both the pH TMDL and the DO TMDL. Brighton's comments are centered on Economic and Permit issues

Brighton Comment 1

Brighton cannot endorse establishment of a TMDL without analysis regarding financial burden. Brighton is under contract with the Metro Wastewater Reclamation District as part of a plan to

decommission its existing Wastewater Plant. Brighton states that it is impractical and financially impossible to expend capital improvement dollars meeting arbitrary compliance limits on a facility already scheduled for decommissioning.

Brighton believes that rushing to establish TMDL limits for the Barr-Milton Watershed is premature. Brighton requests postponement of the establishment of new TMDL standards for the Barr-Milton Watershed until many remaining questions and financial consequences can be addressed.

Division Response: As stated in Division responses above, the TMDL is written to attain the applicable water quality standards. However, the Division has endorsed a staged implementation approach for the TMDLs. It is anticipated that any such approach will incorporate the use of compliance schedules that would provide time for Brighton to connect to Metro's Northern Plant in lieu of making improvements to its wastewater treatment plant. Therefore, it is not expected that full implementation will be immediate.

City of Aurora

The City of Aurora submitted comments on the Barr Milton pH dated July 8, 2011. Aurora expressed appreciation of Division staff's efforts to clarify issues during a BMW stakeholder meeting on June 28, 2011.

Aurora Comment 1

Aurora's main concern with the Division's modifications to the TMDL as seen in the public noticed version of the TMDL related to the Wasteload Allocation section. The Division's changes did not recognize an underlying assumption that formed the basis of the allocations. The assumption, based on modeling results, is that the load reductions for facilities listed in Tables 4.1 and 4.2 will achieve the target in reservoir concentration of 100 ug/L of phosphorus in Barr Lake and Milton Reservoir. This was misconstrued by the Division to mean a discharge limit of 100 ug/L at the end-of-pipe for all facilities. Aurora recommends continuing discussions with the Division to modify the tables and text as needed to match the load allocation of the facilities in the phased TMDL.

Division Response:

As the Division recognizes the discrepancy between the intent of the BMWA draft and the WQCD public noticed TMDL, the TMDL has been revised to reflect the underlying assumptions embodied in the BMWA draft including effluent concentration-based wasteload allocations of 100 ug/L total phosphorus for the three larger facilities. The remaining facilities have effluent concentration-based wasteload allocations of 1000 ug/L. Revisions to the TMDL were made to acknowledge the underlying assumptions and reflect these expected effluent concentrations.

Aurora Comment 2

Aurora is in agreement with comments submitted by the BMW Association

Division Response: So noted.

Aurora Comment 3

Aurora reviewed comments submitted by the Metro Wastewater Reclamation District and is in agreement with specific comments: Section 3-Total Phosphorus Source Analysis, and Section 5-Public Participation.

Division Response: The Division's responses to these comments follow in that section addressing Metro Wastewater Reclamation District's comments.

Barr Lake and Milton Reservoir Watershed Association

The Barr Lake and Milton Reservoir Watershed Association (BMWA) submitted comments to the Division, dated July 8, 2011.

BMWA Comment 1

The Division altered language regarding implementation of the in-reservoir target concentration in Sections 4.2 and 4.3 (footnotes to Tables 4.1 and 4.2) of the TMDL to explicitly require permit limits of 100 ug/L annual average phosphorus for all named wastewater treatment facilities, regardless of rated capacity. The stakeholders object to the changes because the changes would significantly alter the waste load allocation and reduction which the stakeholders agreed to in the draft TMDL and IP submitted to the Division in December 2010. The BMWA is disappointed that the Division made substantive changes to the TMDL without prior consultation with the Stakeholders and simply published them in the public notice version.

BMWA contends that the Division's changes are not needed to achieve the intended in-lake concentrations under the TMDL and could undermine the support of BMWA's members in the implementation of the TMDL.

BMWA requests the opportunity to work with the Division on revising Tables 4.1 and 4.2 with the intent: 1. To modify the TMDL allocation tables to a form acceptable to both BMWA and Division, and that are approvable by EPA Region 8.

2. To clarify the basis upon which the allocations were developed (from both the load and concentration perspectives) and reference the adaptive Implementation Plan as it relates to flexibility in achieving the reductions identified in the allocation tables

3. To ensure that text in Sections 4.2 and 4.3 is consistent with the agreed upon tables.

BMWA proposes that a subgroup of stakeholders be responsible for meeting with the Division staff in a working session style to achieve these objectives.

Division Response: As the Division has stated to BMWA, the Division's revisions to the TMDL were to clarify the focus of the TMDL as being a concentration-based approach. As such, effluent concentrations must be identified in the TMDL. Otherwise, the TMDL will be a traditional load-based TMDL.

The Division revised the allocation tables to correspond to those from the July 2010 BMWA draft of the TMDL. In that draft, effluent concentrations for total phosphorus were 100 ug/L for MWRD, Littleton Englewood, and Centennial and 1000 ug/L for the remaining facilities, which were the concentrations used in the model for determining the loads identified in the tables. If managed as a concentration-based TMDL, these effluent concentrations would be applicable under any facility capacity and any flow condition in the receiving water.

The Barr-Milton TMDL was public noticed from May through August 15, 2011. The Division met with the BMWA during the public notice period and several times after the end of the public notice period to discuss the TMDL and the BMWA's outstanding issues with the TMDL. The dates for these meetings were: June 28, 2011, September 13, 2011, April 24, 2012, and May 21, 2012. Throughout this time, Division staff also responded to additional correspondence, phone and e-mail communications from BMWA and other Barr and Milton Stakeholders.

Metro Wastewater Reclamation District (MWRD)

Metro Wastewater Reclamation District submitted comments on the Barr-Milton pH TMDL dated June 30, 2011.

MWRD Comment 1

Section 3-Total Phosphorus Source Analysis. MWRD opposed a change the Division made to text on page 3.5 which describes the model and allocations.

Section 3-Total Phosphorus Source Analysis: Pg 3-5: The TMDL draft submitted to the Division in December 2010 included a paragraph that stated: "To make the model more accurately predict TP concentrations in Barr over the summer, a very high internal load was needed to counteract the settling observed in the spring. The resultant internal load represents almost 28% of the total load to Barr in the SWAT-WASP model for the two model calibration years, 2003 and 2004." In the PN version, the Division changed the 28% to 5.7%, indicating that the percentage was not consistent with Table 3.1. Metro states that this is not correct. The SWAT-WASP modeling derived a value of approximately 28% internal loading for Barr in order to make the mass balance analysis work. This is explained in the model report (Aug, 2009). Metro recommends changing the paragraph back to the original 28%. They also recommended changing another paragraph to explain the 5.7%.

Division Response: The inconsistency noted by the Division stemmed from the fact that the title for Table 3.1 Loads to Barr and Milton (Based on the SWAT-WASP Model) indicates that the 5.7% was based on the SWAT-WASP model. The text and the tables are confusing in that the table title suggests that the table entries are based on the model, yet the text indicates different values and provides rationale for why something other than model calibration values were used for further assumptions. These inconsistencies are confusing, but the Division has decided to revise according to MWRD's suggestion.

MWRD Comment 2

Section 4-Phased TMDL Technical Analysis

MWRD's comments focus on edits to the PN version of the TMDL that they believe need to be made related to the Division's changes in the TMDL. The Public Notice version of the TMDL now includes "end-of-pipe" limits for all publicly owned treatment works (POTWs) identified as having wasteload allocations. While the revised language in the TMDL document and the footnotes to Table 4.1 and Table 4.2 are consistent with this approach, the reductions described in these tables do not reflect this change. As such MWRD offers revisions of those tables. MWRD's revisions include lumping the Load Allocations for the upstream reservoirs (Cherry Creek, Bear Creek and Chatfield Reservoir) into a single load allocation as "upstream background", and revising the wasteload allocations for each facility.

Division Response: Based on comments received and clarification of the underlying assumptions, the Division is revising the TMDL to the 100/1000 ug/L scenario, as reflected in Tables 4.1 and 4.2. Metro WWTP, Littleton-Englewood WWTP and Centennial WWTP will have effluent TP concentrations of 100 ug/L and the other WWTPs will have effluent TP concentrations of 1000 ug/L. As such changes to loading for Milton Reservoir are not needed. The background loads from the upstream reservoirs remain as individual loads for clarity and historical reference.

Appropriate revisions made.

MWRD Comment 3

MWRD states that the inclusion of "end-of-pipe limits for all POTWs with WLAs is a significant change to the third-party TMDL. Because this point source implementation strategy is more of a "worse case" scenario, it may not necessarily be consistent with the "phased" or adaptive implementation approach as originally envisioned by the BMWA, but rather is more like a TMDL with Staged Implementation. MWRD suggests a general implementation strategy/timeline as a strategy consistent with the "end-of-pipe" requirements that limit or preclude point source flexibilities for POTWs, such as dilution credits or water quality trading opportunities.

"Stage 1: Larger POTWs with wasteload allocations would be required to begin planning and subsequent construction of improvements to meet the 100 µg/L "end-of-pipe" phosphorus effluent
limits at the time of their next regularly scheduled permit renewals once the TMDL is approved by

EPA (e.g., through compliance schedules); MS4s would evaluate and implement additional BMPs;
and in-lake and in-canal scientific studies would continue. Smaller POTWs could be required to evaluate options to meet their wasteload allocations in the future (including funding options), but would not be required to begin design or construction activities until their next (second) permit renewal following TMDL approval.

Stage 2: Load reduction strategies (e.g., in-reservoir and in-canal remediation) would be implemented based on the scientific studies currently underway at the reservoirs (e.g., in Stage 1).

Stage 3: Smaller POTWs with wasteload allocations would be required to meet the 100 µg/L "end-of-
pipe" effluent limits at the time of their subsequent regularly scheduled permit renewals (e.g., planning and construction of improvements using compliance schedules in a second permit renewal).

This approach would provide needed additional time for the smaller communities to evaluate options to meet their obligations under the TMDL since the 100 µg/L "end-of-pipe reductions" will
require treatment levels well beyond conventional biological nutrient removal and will potentially present a higher cost burden to those ratepayers. In addition, even when combined, the total load
from these facilities is only about 2% of the entire phosphorus loading (e.g., to Milton Reservoir). Addressing these smaller loads should be viewed as more of a "long term reduction" from a Staged
Implementation perspective."

MWRD proposed the following language for inclusion in section 4.3 (Wasteload and Load Allocation Strategy):

"Significant water quality improvements will occur once phosphorus reduction facilities are in place at the largest POTWs and in MS4 regulated areas identified in the TMDL. It is therefore appropriate that these improvements be implemented as expeditiously as feasible. Accordingly, reductions at the POTWs with smaller wasteload allocations to 100 µg/L phosphorus end-of-pipe will not be required until evaluations of water quality improvements based on the reductions from the larger POTWs and identified non-point sources have been completed and additional phosphorus reductions are deemed necessary to achieve the in-reservoir water quality goals. However, interim improvements at these POTWs may be required in order to comply with other state regulatory requirements."

Division Response:

The Division has received additional comments subsequent to the public comment period. These comments focus on a perceived lack of flexibility with respect to implementation of the TMDL. Inclusion of the following bulleted items is intended to highlight what the Division believes to be areas where TMDL implementation may be applied in such a way as to offer WWTPs different options in lieu of end of pipe limits as identified in Table 4.1 and 4.2.

Division staff met on May 23, 2012 and identified several points that we believe provide adequate flexibility for implementation of the TMDL.

1. *A phased TMDL approach has been proposed. This allows time for additional studies to address uncertainty in the cause/response linkages between phosphorus loading (cause) and in-lake pH and DO levels (responses).*

2. *Temporary Modifications (TMs) to the existing pH standards currently are in place. The TMDL will not be implemented until the TMs expire 12/31/2015. Additional TMs for DO and extension of the current TMs may be proposed for consideration by the WQCC.*

3. *The TMDL uses a phosphorus concentration-based approach instead of a load-based approach so that point source wasteload allocations and the TMDL itself shouldn't need to be revised when facilities need to increase their capacities or when a new discharger enters the watershed in the future.*

4. *The TMDL provides for staged implementation of source controls. The implementation of point source reductions will be staged, such that the larger POTWs (Littleton-Englewood and Metro Wastewater Reclamation District will implement total phosphorus reductions first, followed by Centennial. Reservoir responses to the actions at these facilities will be evaluated prior to phosphorus reductions being implemented at the smaller POTWs.*

5. *Permitted dischargers have the opportunity to negotiate flexible, long-term compliance schedules as part of the process to incorporate additional effluent limit reduction into existing permits.*

6. *Permitted dischargers can pursue standards actions including site-specific standards and/or temporary modifications, with the WQCC.*

7. *The TMDL does not preclude water quality trading of nutrients in the watershed. A nutrient trading framework has not been described in the TMDL, but can be developed during implementation. The WQCD has a trading policy (Colorado Pollutant Trading Policy, 2004) that provides a framework for trading, although the complexities of the Barr-Milton TMDL may require innovative approaches to trading not anticipated in the policy.*

8. *The BMWA is concerned that the TMDL precludes or restricts nutrient trading. Pollutant trading is considered to be an implementation activity and therefore not specifically identified in the TMDL because of the existing Division policy. However for Barr Lake, the current loads are 90% Point Source and 10% Nonpoint Source. Of the 10% Nonpoint Source, approximately ½ is an internal load to the reservoir from historic deposition that originates primarily from external Point Sources. As such, any Point Source-to-Nonpoint Source trading would trigger the need for "Reasonable Assurance"*

that any nonpoint source reductions will be implemented, assessed, and confirmed. EPA has recently increased its focus on Reasonable Assurance of nonpoint source control implementation. Ultimately, any nutrient trading would have to meet the allocations specified in the TMDL. Any trading policy that is developed would need to address EPA's Reasonable Assurance requirements.

The Division is of the opinion that the concentration-based approach does not preclude trading. The model used actual discharge volumes rather than facility design capacities and used end-of-pipe total phosphorus concentrations of 100 ug/L and 1000 ug/L to model the TP load that reaches the reservoir and attains the pH standards. Therefore, these concentrations are the highest that could be employed as effluent limits. As plant discharge volumes increase, a traditional load-based TMDL would result in ratcheting down of the effluent concentrations. The impaired reservoirs are off-channel reservoirs and diversions to the reservoirs are dependent on water rights. Therefore, the quantity of effluent from each POTW cannot be controlled or predicted, but the quality of the effluent, and thus, the quality of the river water can be controlled. The concentration-based approach is meant to control the total phosphorus concentration in the river. With the concentration-based TMDL approach, effluent concentrations can remain 100 or 1000 ug/L (depending on POTW as in Tables 4.1 and 4.2) even with increases of facility discharge volumes because the water quality of the river will be held constant. Although the model did not account for new discharges, because of the concentration-based approach used in this TMDL and because the TMDL is phased, the Division believes it is appropriate for any new discharges to be required to have effluent TP concentrations of 100 ug/L, end-of-pipe (equal to the in-lake target).

The Division agrees that Staged Implementation is appropriate. As stated in responses to other comments, the TMDL has been revised to reflect the underlying assumptions in the modeling, and thus, end-of-pipe effluent concentrations of 100 ug/L TP apply to Metro WWTP and Littleton-Englewood WWTP, followed by Centennial WWTP, while end-of-pipe effluent concentrations of 1000 ug/L TP apply to the other WWTPs (Tables 4.1 and 4.2). Therefore, the Division modified the language offered by MWRD above to reflect this. The modified language was inserted in the TMDL document in Section 4.3.

"Significant water quality improvements will occur once phosphorus reduction facilities are in place at the larger POTWs with wasteload allocations of100 µg/L phosphorus end-of-pipe and in MS4 regulated areas identified in the TMDL. It is therefore appropriate that these improvements be implemented as expeditiously as feasible. Accordingly, reductions at the POTWs with wasteload allocations of 1000 µg/L phosphorus end-of-pipe will not be required until evaluations of water quality improvements based on the reductions from the larger POTWs and identified non-point sources have been completed and additional phosphorus reductions are deemed necessary to achieve the in-reservoir water quality goals. However, interim improvements at these POTWs may be required in order to comply with other state regulatory requirements."

MWRD Comment 4

MWRD recommends using annual median rather than annual mean. MWRD agreed with the Division's proposal for permit limits based on annual averages. However, they believed that use

of an annual median instead of an annual average (mean) was more appropriate since the 300 ug/L monthly average had been eliminated by the Division.

Division Response: The TMDL was developed using annual means in the model. The goal of the TMDL is protection of the reservoirs. Based on the modeling conducted for this TMDL, there is no basis to use annual medians in place of annual means for effluent limits. Furthermore, based on discussions with WQCD Pemits staff, the Division revised the TMDL to include the original 30-day average as well as the annual average for effluent limits. This is consistent with effluent limits for total phosphorus in other reservoirs in Colorado.

MWRD Comment 5

Section 5- Public Participation

MWRD provides revised language for a paragraph in the Public Participation section, to replace "…~~formation of a technical review committee comprised of representatives of both the public and private sector~~open participation in the 303(d) Listing Methodology Workgroup that is periodically convened…."

Division Response: Noted. New language incorporated.

MWRD Comment 6

Section 8 – Daily Loading Expression

MWRD suggested revisions based on Division's revisions to the TMDL report.

Division Response: So noted. Appropriate revisions were made to the text in Section 8 and to Table 8.1.

MWRD Comment 7

General Comments on the Public Notice Version of Phased Total Maximum Daily Load to Achieve pH Compliance in Barr Lake and Milton Reservoir, Colorado.

MWRD provided general comments supporting the modeling efforts underlying the TMDL and to address potential concerns of some stakeholders over the validity of the TMDL development process and products.

"Basis for the pH TMDL

Development of the Barr Milton pH TMDL has been a complicated and time-consuming process due to the complexities inherent in the numerous sources of phosphorus in the watershed and the sophisticated system of water management activities associated with the reservoirs, including diversions and water transfers. However, the modeling to support development of the

in-reservoir phosphorus targets was conducted in a transparent and collaborative process, and included input from numerous stakeholders including regulated entities, water providers, the Division, and EPA. As such, we believe the "science" underlying the TMDL is comprehensive and takes all major concerns into account.

The Executive Summary of the model report, referred to previously, is shown in *Attachment 4*. We have included this to address potential concerns of some stakeholders over the validity of the TMDL development process, the in-reservoir water quality targets, and the associated wasteload and load allocations. Below is a brief discussion of the modeling framework.

Two models were used to develop the TMDL: (1) the EPA's WASP model (Water Quality Analysis Simulation Program), designed to interpret and predict water quality responses to natural phenomena and man-made pollution to support management decisions, and (2) the U.S. Department of Agriculture's (USDA) SWAT (Soil and Water Assessment Tool), which is a river basin scale model which is used to quantify the impact of land management practices in large, complex watersheds. As stated in the Executive Summary:

The complexity of the Barr-Milton watershed investigation required a novel approach to the development of the watershed and the inlake models. The number and magnitude of water transfers greatly complicated load accounting and required adjustments to the watershed model that were not previously available. AECOM used a modified version of the SWAT model developed by USDA for the watershed simulation. This modification made it possible to acceptably simulate complex water transfers throughout the simulation.

Figure 4-6 of the model report, shown in *Attachment 5*, describes all pertinent water movement around the Barr-Milton watershed, including ditch diversions and return flows.

In addition, the need for an analytical component to understand in-lake processes was identified.
The Executive Summary indicates:

Processes in the reservoirs were influential enough to warrant a separate reservoir water quality model. A recently released version of the WASP model developed by EPA was applied, as it adequately addressed important inlake processes without overcomplicating spatial aspects of the model for which little calibration data were available. The recently released version of the WASP model included an "Advanced Eutrophication" module that can incorporate multiple taxonomic groups of phytoplankton in a water body. This version of the WASP model proved helpful in simulating the progression of algal types in Barr Lake and Milton Reservoir during the year and the related interaction with water quality.

Through Metro District staff participation in the model development and calibration efforts, we are confident that the best currently available modeling tools were used to develop the resulting in-reservoir water quality targets and the phosphorus loading reductions identified in the TMDL.

Note that the modeling report also indicates that additional data collection and evaluation will be needed to refine water quality endpoints and management strategies to achieve those endpoints. Over time, additional data collection and analysis will help refine both point source and non-point source contributions within the watershed and associated management strategies.

As the Executive Summary indicates:
The magnitude and distribution of total phosphorus was favorably mimicked [through modeling], but chlorophyll concentrations proved more challenging to simulate. Control of chlorophyll production (i.e., algal growth) by factors other than phosphorus at such high phosphorus levels is to be expected…
The flexibility of the watershed and lake models makes it possible to simulate additional combinations of management alternatives and the model calibration should be revisited as new data are collected."

Division Response: The Division inserted MWRD's general comments to provide this clarification and to include this information as part of the TMDL.

MWRD Comment 8

Specific Comments on the Public Notice Version of BMW Adaptive Implementation Plan for pH TMDL

Although the Division did not revise the BMW Implementation Plan that was provided with the pH TMDL, MWRD offered a substantive comment and some additional minor editorial comments.

Section 2.2 – Point Sources

MWRD proposes clarifying language in the TMDL to reflect the need to potentially delay implementation of the 100 ug/L phosphorus end-of-pipe limits at the smaller POTWs identified in Tables 4.1 and 4.2 until more significant point and non-point sources have been adequately addressed. We believe that this approach should also be addressed in the Plan. Because the smaller POTWs proportionately represent a minority of loading to the reservoirs, it makes sense to address loading controls in a "top-down" approach, i.e., address the largest source contributors first and evaluate success before moving on to the remaining sources.

Propose language: "…As indicated in the TMDL allocation tables, permit effluent limitations for total phosphorus would be 100 ug/L implemented as an annual average at any hydraulic capacity (rated or existing) for the identified wastewater treatment facilities with wasteload allocations. When combined with other management strategies identified in this Plan this effluent concentration level will allow Barr and Milton to meet the pH standard. Because of the relatively significant capital and operating costs associated with this level of phosphorus removal and the comparatively minor contributions from the smaller POTWs identified in Tables 4.1 and 4.2 in the TMDL, it is expected that implementation of the 100 ug/L phosphorus effluent limitations at these facilities will be delayed until reductions have been made at the larger POTWs and from other sources identified in Tables 4.1 and 4.2 in the TMDL."

Division Response: As has been clarified in Division Responses to other comments, the Division revised the TMDL to reflect the underlying assumptions of the model so that MWRD, Littleton-Englewood, and Centennial POTWs will have effluent limits of 100 ug/L Total Phosphorus, while the remaining smaller facilities will have effluent limits of 1000 ug/L Total Phosphorus.

The Division agrees that staged implementation for this phased TMDL is appropriate. Therefore, it is expected that the effluent limits for the larger POTWs will be implemented (MWRD and Littleton-Englewood, followed by Centennial) first, and that implementation of the phosphorus effluent limits at the smaller facilities with 1000 ug/L Total Phosphorus will be delayed until reductions at the larger POTWs have been evaluated.

The Division made appropriate revisions to the Implementation Plan.

Parker Water & Sanitation District (PWSD)

The Division received comments from Ronda L. Sandquist, Squire, Sanders & Dempsey (US) LLP on behalf of Parker Water & Sanitation District (PWSD), dated June 30, 2011.

PWSD Comment 1

PWSD requests that the TMDL delete Cherry Creek Reservoir from designation as background source and remove all references that implicate Cherry Creek Reservoir or point sources upstream of Cherry Creek Reservoir in the reduction of P, or participation in any manner in projects designed to reduce concentration or loads to and within the lakes.

Division Response: Cherry Creek Reservoir, and the other upstream reservoirs are identified as background and fall into the Load Allocation of the Barr Milton TMDL. As such, there are not implications for point sources situated in these basins. TMDLs must identify sources, and background loads. However, there is no permit requirement for the reduction of load allocations, and since the upstream reservoirs of Cherry Creek, Chatfield Reservoir, and Bear Creek Reservoir fall under the Load Allocation, there are no implications for permit-based controls or reductions in the Cherry Creek Basin from the BMW TMDL. The Division believes that adequate efforts are being made in the Cherry Creek Basin to address phosphorus control (Cherry Creek Reservoir Control Regulation, 5 CCR 1002-72), and does not anticipate any further regulatory requirements beyond what is required by the Cherry Creek Basin Control Regulations. Phosphorus controls required by the Cherry Creek Basin Control Regulation are adequate to control phosphorus downstream, over time.

PWSD Comment 2

PWSD Comment on DO Addendum: PWSD states that the DO Addendum violates 40 C.F.R. § 130.7(a) and (c)(1)(ii) and is not in accordance with the TMDL process outlined in Colorado's Water Quality Management and Drinking Water Protection Handbook.

Division Response: As stated in the Commission Policy #98-2, the Division has the overall responsibility to complete TMDLs for all segments on the 303(d) List. The Commission Policy #98-2 also states "A rigid procedural approach to the completion of TMDLs in inappropriate. The wide variety of water bodies, parameters and local stakeholder group evolution dictates that

the Division retain a flexible approach to problem solving." Milton Reservoir was added to the 2010 303(d) List for impairment due to dissolved oxygen; Barr Lake was added to the 2010 Monitoring and Evaluation List for dissolved oxygen. Shortly after this, the Division suggested to the BMWA stakeholders group that they could include Dissolved Oxygen TMDLs with the pH TMDLs. The BMWA did not pursue this. However, the Division determined it would be more efficient and cost-effective to include DO TMDLs. The Division determined that the targets for the pH TMDLs were appropriate to address the Dissolved Oxygen impairments, and that, as a phased approach is being utilized for the pH TMDLs, it is appropriate to include the Dissolved Oxygen TMDLs at the same time. This effort saves the BMWA and the Division a great deal of time and resources. Subsequently, in 2012, Barr Lake was moved to the 303(d) List for dissolved oxygen impairment.

Regarding PWSD's statements related to 40 C.F.R. § 130.7(a) and (c)(1)(ii), the Division participated in the BMWA stakeholder process for the development of the pH TMDL, and as stated above, had suggested the BMWA include DO TMDLs with the pH TMDL. It was only late in the process that the Division realized it could provide that effort for the BMWA. The Division's intent was to save itself and BMWA resources by combining the DO TMDL with the pH TMDL. Ultimately, because the targets are the same for both pH and DO TMDL, including the DO TMDL has no additional impact to the BMWA, other than saving them resources. Furthermore, the DO TMDL was available for public review through the public comment period, which is identified in Commission Policy #98-2. The precedent for this public comment period is 30 days, however, the public comment period for the DO TMDL was extended to 75 days from May 1 through August 15.

PWSD Comment 3

PWSD states the DO TMDL is without scientific justification because it was developed using data and information from other Colorado lakes. PWSD states, "Repudiating site-specific data violates EPA's TMDL requirements. *See* 40 CFR 130.7(c)(1)(i)"site-specific information should be used wherever possible."

Division Response: The Division reviewed site-specific data and determined it was not fully adequate to develop the Dissolved Oxygen TMDL. As in development of the pH TMDL, data from comparison lakes was needed to identify phosphorus concentrations under non-impaired conditions. While site-specific information is ideal, use of comparison data is not precluded by 40 CFR 130.7(c)(1)(i).

The Division and EPA agree that it is appropriate to develop targets using data from other sites. In fact, the Division and EPA had recommended that data from comparable lake be used in development of the BMW pH TMDL because phosphorus data in the range of pH standard attainment was not observed in Barr Lake and Milton Reservoir. The comparison lakes the Division used in development of the DO TMDL are appropriate, based on stratification patterns. These comparison lakes, as well as Barr Lake and Milton Reservoir, are in the group that

stratifiy intermittently. It has been proven by several researchers that mean depth and water retention time are primary determinants of phosphorus loading permissibility. Thus, it is appropriate to use comparable lakes in this case.

Ultimately, the Division is looking for data in the range that would reasonably be expected to attain standards. Since site-specific data (Barr and Milton Data) rarely exhibit this, it was reasonable to supplement with data from other comparable reservoirs. Because the Division is looking at DO and chlorophyll a and TP, it needed comparable data for all three variables. However, although TP concentrations sometimes fall below 200 ug/L in Milton, levels below 200 ug/L are not observed in Barr Lake.

PWSD Comment 4

EPA clearly mandates that TMDLs be completed first for waters on the 303(d) list and that other waters, such as the DO Addendum, are subject to available State Resources. While Colorado is declaring budget shortages and the Division routinely references insufficient resources, the Division now has found the resources to complete an unmandated TMDL

Division Response: The Division has the overall responsibility to complete TMDLs for all segments on the 303(d) List. When the Division is in the process of developing TMDLs for impaired water bodies on the 303(d) list, it occasionally finds evidence that the listed waterbodies are impaired for other pollutants and will be added to the next 303(d) List. In such cases, it is time-efficient, and cost-effective for all parties, to develop a TMDL for the additional pollutant(s). In the case of Barr Lake and Milton Reservoir, Milton Reservoir was added to the 2010 303(d) List of Impaired Waters for exceeding the dissolved oxygen standard, and Barr Lake was added to the 2010 Monitoring and Evaluation List for dissolved oxygen. Subsequently, the DO impairment for Barr Lake was confirmed via its addition to the 2012 303(d) List.

PWSD Comment 5

PWSD claims there is a lack of scientific basis for the pH TMDL because the draft TMDL acknowledged "the lack of direct correlation" between pH, chlorophyll a, and TP.

Division Response: Although the relationship between pH and chlorophyll a has not been precisely quantified, there is no doubt in the scientific community that such a relationship exists. Furthermore, correlation is not the only statistical descriptor of a scientific relationship. EPA has indicated that phased TMDLs are appropriate where uncertainty exists. The TMDL acknowledges the existence of uncertainty and this is accounted for by phasing the TMDL.

PWSD Comment 6

The TMDL indicates there are multiple ways to achieve pH compliance but offers no detail regarding why alternatives were not pursued, despite the lack of direct correlation of the existing approach. At a minimum, third-party technical review should occur regarding how the phosphorus water quality target was derived. While phased TMDLS may be used where there

are limited existing data, the complete lack of scientific basis for the TMDL even precludes phasing the TMDL. Because the TMDL cannot confirm that TP reductions will reduce the pH levels, the Division should not proceed with a phased TMDL that would commence implementation of TP limitations at great expense.

Division Response: TMDLs address impairments through source controls of pollutants. In this case, impairments for pH are addressed through phosphorus source controls. The alternatives the TMDL referred to suggest treatment of symptoms, rather than source controls, which is beyond the scope of a TMDL, and it was not necessary to explore such in a TMDL.

The Division disagrees with the commentor's position that there is a complete lack of scientific basis for the TMDL. It is a biological, and thus, scientific fact that photosynthetic activity drives the carbon cycle, resulting in the increases in pH, as is observed in these impaired lakes. It follows, that reducing algal productivity by reducing total phosphorus, will reduce the observed pH excursions. This approach is used in other states for TMDLs.

As explained in the TMDLs, high pH and low dissolved oxygen are symptoms of excess algal production, which is related to excess nutrients. Reducing phosphorus is routinely recommended to improve the symptoms of eutrophication. Many states, including Utah, California, Wisconsin, Vermont, have developed phosphorus TMDLs to address impairments due to pH and dissolved oxygen.

PWSD Comment 7

Background Load Allocations: PWSD comments on the 75% load reductions identified in the BMWA TMDL for the Cherry Creek Reservoir outflow. They emphasize the Cherry Creek Basin's lead in phosphorus regulation in Colorado and highlight the successful low-level phosphorus removal performance of the wastewater treatment plants in the Cherry Creek Basin.

Division Response: The Division reiterates that the load identified for the Cherry Creek Reservoir Outflow is a load allocation, and not a wasteload allocation, and therefore has no implications for facility permits upstream of the reservoir. The Division recognizes that the Cherry Creek Basin is under a Control Regulation that manages phosphorus, and that facilities in the Cherry Creek Basin perform phosphorus removal at levels below what is identified for facilities in the Barr Lake and Milton Reservoir TMDL.

PWSD Comment 8

PWSD suggests that since Barr and Milton were constructed by FRICO for its agricultural water storage, the operators exercise exclusive control over when flow enters the reservoir and also have complete control over the total phosphorus load that reaches the lakes. PWSD also states that because FRICO will make large profits from the water supply use, that FRICO should bear the burden and costs to make the reservoirs suitable for the new use.

Division Response: Barr Lake and Milton Reservoir include multiple classified uses. The 2012 303(d) Listed Impairments for Barr Lake and Milton Reservoir are for pH and Dissolved Oxygen.

These standards (pH and Dissolved Oxygen) are protective of Aquatic Life and Recreation Uses, in addition to the Water Supply Use. A TMDL must include wasteload allocations for point sources and that those reductions are the responsibility of the owner, not a third party. Also, the Commission designates uses for waters throughout the state and the fact that FRICO puts the water to use is no different than any other entity (city, citizen, et.) that benefits from water that is protected by the classification and standards process.

PWSD Comment 9

PWSD states FRICO's canals bring agricultural return flows which contain nutrients and contaminants from agricultural lands, to Barr Lake and Milton Reservoir. The Clean Water Act only exempts discharges entirely composed of return flows from agricultural irrigation, but not the instant contaminated groundwater, or the intercepted storm and nonpoint sources. FRICO's canals contain waters that are not solely agricultural return flows so they are not entitled to exemption.

Division Response: The SWAT model accounts for the fate and transport of phosphorus within the watershed, including agricultural return flows.

PWSD Comment 10

PWSD concludes that because Barr Lake and Milton Reservoir are off-stream reservoirs, local measures to control phosphorus loads are entirely within the hands of the operators of the reservoirs, and additional water control and agricultural practices/management strategies should be implemented as a first course of action to reduce phosphorus loads.

Division Response: Barr Lake and Milton Reservoir and the canals that feed them are waters of the state as described in as defined in Regulation 31. Regulation 31 includes the formal definition at 31.5

"STATE WATERS" means any and all surface and subsurface waters which are contained in or flow in or through this state, but does not include waters in sewage systems, waters in treatment works of disposal systems, waters in potable water distribution systems, and all water withdrawn for use until use and treatment have been completed.

These reservoirs are included in Regulation 38- Classifications and Numeric Standards for South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin in Middle South Platte Segment 4.

PWSD Comment 11

PWSD concludes that the Barr-Milton pH and DO TMDLs are not ready for approval as they claim the science is lacking and this is not merely an issue requiring collection of more data. There is uncertainty regarding the relationships among pH, TP, and chlorophyll a, the calculated magnitude of the existing TP load, the derivation of internal loading of TP, and the future effect of alkalinity on pH attainment. PWSD claims additional analysis and consideration of stakeholder comments is required.

Division Response: Development of the Barr Milton TMDL has been an extensive and comprehensive process over many years. As indicated in the TMDL report, the TMDL is proposed as a phased TMDL in order to account for the uncertainties in the relationships. Although the relationships are not entirely quantified, the relationships are biological, and therefore scientifically defensible. The approach of using a phased TMDL allows for additional analysis, while still making progress in much needed pollutant reductions. The TMDL development process has been a public and collaborative process throughout, and has culminated in an extensive public comment period. At this time, the Division believes the requirements for a phased TMDL have been met and that, with revisions in response to the Public Notice period, the TMDL is suitable for submittal to EPA.

PWSD Comment 12

PWSD states that if the TMDL is approved despite significant flaws, references to loads from Cherry Creek Reservoir and any target reductions should be removed from the TMDL. There is no basis for the proposed drastic reduction in phosphorus load from Cherry Creek Reservoir. It should also be clear that Cherry Creek Basin point source dischargers, which are complying with their permits and Regulation 72, will at no time be given a specific allocation. The Plan should also reflect this approach.

Division Response: Sources to the impaired reservoirs must be identified in the TDML. As such, it is appropriate that Cherry Creek Reservoir be identified as a background source. There is no need to remove Cherry Creek Reservoir from the TMDL. It is identified as a background source which falls under the nonpoint source Load Allocation component of the TMDL. As such, there are no WLAs for dischargers upstream of Cherry Creek Reservoir resulting from this TMDL. The Division agrees with PWSD that point source dischargers in Cherry Creek Basin are complying with their permits and Regulation 72, and that phosphorus controls in all the control regulation basins are expected to result in benefit to the BMW TMDL.

PWSD Comment 13

PWSD is concerned that there has been no meaningful consideration of funding and it appears that no source of payment for the in-canal treatment has been identified. PWSD states that the Cherry Creek Basin WWTPs should not be targeted to pay for cleanup outside their watershed while FRICO prospers selling water for municipal uses.

Division Response: Noted

Littleton-Englewood (Hill & Robbins, P.C.)

The Division received comments from Littleton/Englewood Wastewater Treatment Plant dated July 7, 2011. Many of the comments questioned legalities of the TMDL. Few, if any, of the issues raised were technically or scientifically based.

Littleton-Englewood (Hill & Robbins, P.C.) Comment 1

Under the proposed TMDLs, the phosphorus contribution of agricultural and other non-point sources is characterized as being minimal. Therefore, the burdens of compliance with the phosphorus reduction that would be mandated by the draft TMDLs are placed directly upon local governments and the Colorado residents and businesses within those local governments that pay for wastewater treatment at the Littleton/Englewood Wastewater Treatment Plant, and other facilities, including those operated by the Denver Metropolitan Wastewater Reclamation District, and Centennial Water and Sanitation District.

Division Response: The TMDL characterizes existing contributions, and identifies pollutant reductions required to attain the water quality standards. An extensive TMDL development process was employed during which a detailed watershed model was developed. The results are that, indeed, nonpoint source contributions are relatively minimal when compared to the three facilities noted.

Littleton-Englewood (Hill & Robbins, P.C.) Comment 2

Colorado law requires that prior to taking final action, other than enforcement action, the Division must take into account the costs, benefits, and economic reasonableness of the action. Moreover, Governor Hickenlooper's Executive Order D 2011-005 specifically directs state agencies to refrain from imposing requirements creating a mandate on local governments unless (1) specifically required by federal or state law, (2) the agency consults with local governments prior to promulgation, and (3) the state government provides the funding necessary to pay the direct costs incurred by local governments in complying with the mandate.

Division Response: By its terms, Exec. Order D 2011-005 only applies to regulations adopted by state boards or commissions. Since TMDLs are not regulations, EO5 does not apply to this TMDL.

Littleton-Englewood (Hill & Robbins, P.C.) Comment 3

Phosphorus removal is extremely expensive. The draft TMDLs do not address, or even mention, the capital and operation and maintenance costs of phosphorus removal facilities, and provide no discussion of how such costs will be allocated or funded.

Division Response: These issues are beyond the scope of a TMDL. The TMDL identifies sources and determines the pollutant reductions necessary to attain water quality standards and legally cannot be dictated by costs.

Littleton-Englewood (Hill & Robbins, P.C.) Comment 4

When compared to the enormity and widespread impact of these costs, the benefits of the TMDLs appear to be questionable at best. The stated purpose of the TMDLs is to protect aquatic life in Barr and Milton Reservoir. Those reservoirs are off-channel, privately owned, shallow plains reservoirs that have been historically used for irrigation purposes…..Adoption of TMDLs for such structures would be unprecedented in Colorado or anywhere else in the United States.

Division Response: As previously stated, TMDLs are not required to include cost-benefit analyses. The TMDL is required to be written to attain water quality standards that are set to protect the classified uses of the impaired waterbody. As discussed in the TMDL report, Barr Lake and Milton Reservoir are waters of the state in Middle South Platte Segment 4 of the South Platte Basin, and include the classified uses of aquatic life warm, recreation, water supply and agriculture. In addition, Bar Lake is within a state park and wildlife area.

Littleton-Englewood (Hill & Robbins, P.C.) Comment 5

Although the in-lake source of nutrients was discussed in the draft TMDLs, no specific cost estimate for dredging or other remediation was performed, and there was no discussion of how the costs of such remediation would be allocated or funded.

Division Response: TMDLs are required to identify pollutant source reductions. They are not required to estimate costs for said reductions.

The TDML includes an allocation for internal loading of phosphorus, although, at this point, internal loads are minor sources. The internal loads are under the Load Allocation category. The Division and EPA believe that, as internal loads are legacy of external (watershed) loads, which are predominantly from point sources, that control of internal loads without adequate control of point sources will be ineffective. Overall, however, in this phased TMDL, control of point and nonpoint sources of phosphorus will be staged.

Littleton-Englewood (Hill & Robbins, P.C.) Comment 6

In a 2000 rulemaking hearing, the Commission considered a proposal by FRICO and others to establish phosphorus and other nutrient standards for Barr and Milton Reservoirs. After a multi-day hearing and on a complete evidentiary record, the Commission decisively rejected the proposal based largely on evidence presented to the Commission regarding the limnology of Barr and Milton Reservoirs, the lack of sound science supporting the proposal, and that the huge costs of compliance with the proposed standards would not justify the benefits. The draft TMDL contains no analysis or basis for the Division to reach a different conclusion from that reached by the Commission after a full and complete hearing.

Division Response: These are different issues entirely. The TMDL is a different process than setting standards, and it has a different purpose. The TMDL is about attaining the pH standard in Barr Lake and Milton Reservoir. It does this through reducing algal production through control of total phosphorus. The TMDL does not set standards. Furthermore, the TMDL is based on an extensive and detailed modeling exercise that included analysis of complex

watershed hydrology and existing loading conditions. TMDLs are developed to describe what needs to happen to attain water quality standards. TMDLs are not required to address economic implications.

Littleton-Englewood (Hill & Robbins, P.C.) Comment 7

The draft TMDL contains no indication that the Division has engaged in the cost-benefit analysis required by statute after evaluating the magnitude and costs involved in implementing and complying with the phosphorus removal requirements of the draft TMDLs and showing that implementation and compliance would be economically reasonable. Nor does it appear that the Division has taken into account the unique geographical, hydrological, ownership, and limnological facts of Barr and Milton that were presented in the prior Commission hearing in which the Commission rejected nutrient standards for Barr and Milton Reservoirs. In addition, the Division has not consulted with the elected officials of the Cities of Littleton and Englewood or identified a state funding source to pay for the mandated phosphorus removal as required by the Governor's recent executive order.

Accordingly, the draft TMDLs should be withdrawn until the Division has conducted the requisite cost-benefit analysis and made a showing that the draft TMDLs are economically reasonable and otherwise appropriate for Barr and Milton Reservoirs……

In the event that the Division determines to proceed with approval of the draft TMDLs without resolving these issues, Littleton/Englewood requests that the matter be referred to the Commission for an adjudicatory hearing in accordance with Commission Policy #98-2, Section V.B.2.

Division Response: The cost/benefit analysis referred to is the legislative declarations found in C.R.S. §25-8-102(5). TMDLs are an allocation of pollutants and do not in themselves involve costs. The appropriate time to consider costs is in the standards setting process and, possibly, in discharge-specific variance proceedings.

A request for an adjudicatory hearing would occur after final agency action. Currently, Water Quality Control Division final agency action is defined when the Division formally submits the TMDL to EPA for approval.

Barr Lake and Milton Reservoir Watershed Association

The Barr Lake and Milton Reservoir Watershed Association (BMWA) submitted comments to the Division on the Barr/Milton Phased DO TMDL Addendum to the BMW Phased pH TMDL, dated August 15, 2011.

BMWA Comment 1:

The BMWA agrees that the proposed phased pH TMDL and the associated targets of 25 ug/L for Chlorophyll a and 100 ug/L maximum and 40-60 ug/L average for in-reservoir total phosphorus will also result in attainment of the DO standard for both reservoirs. The BMWA understands that adoption of the DO TMDL will not result in any additional permit limits for POTWs

Division Response: Noted

BMWA Comment 2:

The DO TMDL references the interim nutrient values identified in a draft proposed Regulation 31.17. As these are proposed values that have not yet been reviewed or adopted by the Water Quality Control Commission as appropriate for use in water quality decision making, the Association requests that references be removed from the DO TMDL.

Division Response: The text in the DO TMDL addendum explains that these values are proposed values and, as of the date the TMDL was public noticed, had not been adopted by the Water Quality Control Commission. Reference to these values does not make them official standards. Only adoption by the Water Quality Control Commission can do so. The values were referenced to illustrate one of many lines of reasoning for setting TMDL targets and to illustrate the range of potential total phosphorus targets. The proposed values represented the higher end of a range of total phosphorus targets. Ultimately these values were not selected for the TMDL.

In consideration of stakeholder-raised concerns of the lines of reasoning offered by the Division in the DO TMDL, the Division noticed that the EPA 304a nutrient criteria had not been included, and has determined that the 304a criteria for total phosphorus and chlorophyll a concentrations should be included to fully represent the range of potential targets for the DO TMDL.

EPA's recommendations were based on analysis of aggregated ecoregions and Level 3 ecoregions. Both aggregate (Table 1) and Level 3 ecoregion (Table 2) criteria applicable to Colorado are presented here. The EPA recommended criteria represent the 25th percentile of measured values. EPA's recommended criteria are lower than other targets that were presented in the Barr Lake and Milton Reservoir TMDL.

Table 1.

Aggregate Nutrient Ecoregion	TP, mg/L	Chl a, ug/L
II. Western Forested Mountains	*0.009*	*1.9*
III. Xeric West	*0.017*	*3.4*
IV. Great Plains Grass and Shrublands	*0.020*	*2.0*
V. South Central Cultivated Great Plains	*0.033*	*2.3*

Table 2.

Level 3 Ecoregion	TP, mg/L	Chl a, ug/L
18: Wyoming Basin	*0.010*	*1.4*
21: Southern Rockies	*0.015*	*1.7*
20: Colorado Plateaus	*0.003*	*1.4*
22: Arizona/New Mexico Plateau	*0.015*	*2.0*
25: Western High Plains	*0.024*	*2.4*
26: Southwestern Tablelands	*0.020*	*1.2*

BMWA Comment 3:

BMWA states that as an addendum to the proposed phased BMW pH TMDL, the DO TMDL should rely upon the analysis and conclusions in the pH TMDL and the associated implementation plan. Attainment of the DO standard will be achieved using the same phased approach as set forth in the pH TMDL. As such, the DO TMDL and pH TMDL should be consistent with one another, as noted below:

- The DO TMDL summary page does not reflect the 100 ug/L maximum that is provided in the pH TMDL cover page.

- The Chl target in the proposed phased DO TMDL addendum was stated as being 20 ug/L as an 80th percentile of summer averages and as a maximum of 25 ug/L. This was never stated in the phased pH TMDL and is not consistent with the proposed 25 ug/L Chl target.

- The phased pH TMDL only references Denver area lakes in developing the 25 ug/L Chla target. No other lakes or reservoirs in the state were used. As an addendum to the phased pH TMDL, the approach to defining the Chl target in the DO TMDL should be consistent. If necessary, Figures 1 and 3 can be replaced with graphs using the same Denver-area lakes that were used to develop the phased pH TMDL, as provided in BMWA's comments. In addition, since Figure 2 does not provide additional/new information, we suggest that it be removed; thus, BMWA's figures are labeled to reflect removal of Figure 2.

Division Response: The DO TMDL summary page will be revised to include the 100 ug/L total phosphorus maximum.

The DO TMDL was developed with a different data set than the pH TMDL. The 80th percentile stated in the DO TMDL is merely a different statistic of the dataset, and does not change the maximum target of 25 ug/L. It should be noted, that the chlorophyll values discussed were used as translators for developing the total phosphorus TMDL targets.

The DO TMDL addendum was developed with a different data set from the pH TMDL. The Division used comparison lakes it deemed more appropriate for examining the dissolved oxygen impairments, that is, the set of comparison lakes was selected based on median depths and stratification potential. The Division classifies the pH TMDL's Denver area lakes as not-stratified. Stratification is an important factor for dissolved oxygen. As such, it is acceptable to use different data sets for the different pollutant impairments (Dissolved Oxygen vs. pH) to define TMDL targets. The targets identified from the Division's separate analysis for dissolved oxygen are in the range of those in the pH TMDL. This resulting agreement lends an additional line of support for the TMDL targets for both of the eutrophication-related impairments. Because both analyses result in the same targets, the loading component and associated reductions modeled for the pH TMDL can be applied to the dissolved oxygen TMDL. The pH TMDL analysis for setting targets did not include an analysis of dissolved oxygen, therefore, it is not appropriate to delete or replace the Division's analysis.

BMWA Comment 4:

BMWA states that DO TMDL data analysis is heavily skewed by Fruitgrowers Reservoir, and that Fruitgrowers Reservoir is an outlier. BMWA also states that Figure 1 is biased and does not show the true variability of Chl and DO.

Division Response: The Division's protocol, when assessing dissolved oxygen profiles from lakes, requires that all profiles be included, thus, all Fruitgrowers Reservoir profiles were included in the Figure 1. The text also explains that the regression was not strong and that the figure was focused on the lower left side of the plot by fixing the X and Y axes. The purpose was

not to explore variability in the data, rather the purpose was to look for a threshold in which dissolved oxygen impairments weren't observed. The Division did not focus on the higher end of the x axis, because other impairments such as high pH occur with high chlorophyll, as is observed in Barr Lake and Milton Reservoir. Obviously, a target would not be selected that would be conducive to other (pH) impairments.

Also note that the figures only present data for which paired dissolved oxygen and chlorophyll values were available. The figure presented by BMWA is inconclusive. Oxygen impairments have been identified for several of the lakes included in their analysis (several of those lakes are 303(d) listed for dissolved oxygen), however, BMWA's figure does not show any low dissolved oxygen. The Division examined the Denver area lakes data, and paired chlorophyll values were not available.

The Division expects that refinements in dissolved oxygen dynamics, including a more complete data set with paired DO and chlorophyll will result during the phased TMDL, just as refinements in the pH dynamics will be identified.

BMWA Comment 5:

Because of their issues with the analyses of the DO TMDL, BMWA requests that the Division revise the DO TMDL to include only the first four paragraphs of the DO TMDL addendum.

Division Response: As stated in the Division's responses above, the DO TMDL addendum was based on independent analyses to determine appropriate targets, and presentation of these analyses is appropriate.

March 2013.

After the public notice period for the Phased Total Maximum Daily Load to Achieve pH Compliance in Barr Lake and Milton Reservoir, Colorado Report (BMW pH TMDL) and Total Maximum Daily Load Assessment (Addendum) Barr Lake and Milton Reservoir for Dissolved Oxygen Report (DO TMDL), the Water Quality Control Division (Division) prepared responses to comments and revised the reports accordingly. The Division provided the revised reports with responses to comments to the Barr Milton Watershed Association (BMWA) in August 2012. The BMWA contacted Division management and requested additional meetings with the Division to continue revising language in the TMDL reports. The Division met with BMWA in October and November 2012. On November 14, 2012, the Division met with BMWA representatives to discuss revisions and additions to the BMW pH TMDL and Implementation Plan documents to address BMWA's concerns. The BMWA continued revising the documents, and on March 4, 2013, the BMWA submitted their revised drafts to the Division.

The following describes the revisions BMWA proposed and the Division's responses to the revisions. In addition to the Division responses to BMWA's proposed changes, the Division revised relevant dates on the title pages and headers and footers to April 2013.

Revisions to: Phased Total Maximum Daily Load to Achieve pH Compliance in Barr Lake and Milton Reservoir, Colorado.

BMWA's revisions to the BMW pH TMDL are:

1. Tables 4.1 and 4.2. BMWA made revisions to Tables 4.1 and 4.2:
    a. Under Loads, in the Source of Phosphorus column, the individual upstream reservoirs (Cherry Creek Reservoir, Bear Creek Reservoir and Chatfield Reservoir) were replaced with "Upstream Background Loads"; the individual Current Loads were replaced with the sum; the Load Reduction Rationale was modified as: "~~Reservoir concentrations are considered to be background for the Barr Lake Watershed. Background load is t~~Targeted for a 75% reduction through in-canal treatment in the …..".
    b. Footnotes to Tables 4.1 and 4.2 included an additional statement: "Interim effluent limitations of 1000 ug/L for the Burlington Pump Works, Littleton-Englewood WWTP, and Centennial WWTP will be implemented in the same fashion."
2. Additional language was incorporated in the text in Section 4.3.
3. Changes to Table footnotes (Table 1.2, Table 1.3).

Division Response:

1. The Division incorporated the revisions to Tables 4.1 and 4.2. For the final statement in the Table 4.1 and 4.2 footnotes, the intent is that the interim effluent limitations be

implemented as described in Regulation No. 85. The Division confirmed this with BMWA and made appropriate changes such that the final statement is: "Interim effluent limitations of 1000 ug/L for the Burlington Pump Works, Littleton-Englewood WWTP, and Centennial WWTP will be implemented as described in Regulation No. 85."

2. The additional language in the text was developed during a meeting with BMWA representatives and Division staff. The Division incorporated the language in the final pH TMDL.
3. Websites were referenced by BMWA in the Table 1.2 and Table 1.3 footnotes. However, when the Division tested these website references, they did not lead to the cited information. The Division changed the footnotes to cite the source of the information rather than a website.

Revisions to: BMW Adaptive Implementation Plan For pH TMDL

The BMWA revised and updated the Implementation Plan.

Division Response: The Division accepted BMWA's revisions to the Implementation Plan and also changed dates on title pages, headers and footers to April 2013.

Revisions to: Total Maximum Daily Load Assessment (Addendum) Barr Lake and Milton Reservoir for Dissolved Oxygen.

The BMWA's revised draft of the Public Notice version of the DO TMDL are:

1. Adding 0.100 mg/L (maximum) to the Total Phosphorus target in the TMDL summary table.
2. Revising text to include more detail about the pH TMDL and Implementation Plan.
3. Changing the plural "TMDLs" to singular "TMDL" and modifying associated grammar to singular forms.
4. Deleting details of the approaches used in development of the DO TMDLs, particularly detail discussing proposed interim numeric values for nutrients.

Division Response: Revisions to the DO TMDL were not discussed with the Division during any of the post-public notice meetings. BMWA proposed revisions to the public notice draft of the DO TMDL report for Barr Lake and Milton Reservoir rather than to the August 2012 version the Division provided to the BMWA

1. The Division's August draft of the DO TMDL already included item 1 above.
2. The Division developed the DO TMDLs independently from the BMWA's development of the BMW pH TMDLs. However, the reports will be submitted to EPA concurrently. Therefore, additional text detailing the pH TMDL is unnecessary.

3. Although Barr Lake and Milton Reservoir are in the same segment, they are separate waterbodies and are impaired for more than one parameter. Thus, multiple TMDLs are proposed. Using the singular form is not correct.
4. The Division received comments on the DO TMDL from BMWA following the formal Public Notice Period (May 1-August 15, 2011). The Division addressed BMWA's comments on the DO TMDL in the Response to Comments, which was attached to the August 2012 pH TMDL document the Division provided to BMWA. Those responses still apply to most of the revisions BMWA proposed again in March 2013. The Division does not agree with BMWA's rationale for deleting references to the Division's proposals for interim numeric values for nutrients. The proposed interim numeric values for nutrients were referenced to illustrate one of many lines of reasoning used in establishing a linkage analysis for setting the TMDL targets and to illustrate the range of potential total phosphorus targets. The interim numeric values represented the higher end of a range of potential total phosphorus targets. Although these values were not selected as the TMDL targets and these TMDLs are proposed as phased TMDLs which will ultimately lead to revisiting the targets, it is important to document in the TMDL document how the targets were determined.
   At the time the TMDL was public noticed, the State of Colorado had not adopted statewide nutrient criteria or standards, although draft interim numeric values were being proposed in a separate but concurrent process. During the nutrient criteria development process, the BMW pH TMDL and the DO TMDL were public noticed. The DO TMDL report described approaches the Division used to identify linkages between nutrient loading and reservoir dissolved oxygen. The BMW pH TMDL analysis for setting targets did not include an analysis of dissolved oxygen, therefore, it is not appropriate to delete or replace the Division's analysis.

   Subsequent to the public notice of the DO TMDL report, but prior to the finalization and submittal of the TMDL report to EPA, the Water Quality Control Commission (WQCC) held a rule-making hearing (RMH) on nutrient criteria. The proposed interim numeric values (dated October 2010) discussed in the DO TMDL report were modified before the RMH. The final values adopted by the WQCC into Regulation 31 (effective date September 20, 2012) are presented in the Table 2 below.

Classification	Aquatic Life[2]		
	Chlorophyll (ug/L)	Total P (ug/L)	Total N (mg/L)
Cold	8[2]	25[1]	0.426
Warm	20[2]	83[1]	0.910
1 – summer (July 1-September 30) average Total Phosphorus (ug/L) in the mixed layer of lakes (median of multiple depths), allowable exceedance frequency 1-in-5 years.			
2 – summer (July 1-September 30) average chlorophyll a (ug/L) in the mixed layer of lakes (median of multiple depths), allowable exceedance frequency 1-in-5 years.			

Table 2. Colorado final interim numeric values for lakes.

Final draft pH TMDL and DO TMDL reports were provided to the Barr Milton Watershed Association (BMWA) in August 2012. The Division agreed to BMWA's revisions to the BMW pH TMDL report and Implementation Plan documents. These revisions were completed by BMWA and submitted to the Division in March 2013.

The Division prepared additional responses to comments and finalized the documents. The Division updated the dissolved oxygen TMDL report by adding additional discussion and Table 2 in the Public Participation section. As a courtesy, the final documents were provided to the BMWA in April 2013.

April 2013

The Division provided a courtesy copy of final TMDL documents to BMWA on April 15, 2013. Although the Division did not request additional comments, on April 24, 2013, BMWA responded with additional requested revisions to the BMW pH TMDL report. MWRD e-mailed supporting comments to clarify the additional revisions. BMWA was concerned that the TMDL footnote was not consistent with Regulation No. 85 and that implementation of the TMDL would result in permittees being out of compliance with Regulation No. 85. BMWA wanted to avoid permit implementation conflicts between the TMDL and Regulation No. 85 for facilities subject to Regulation No. 85.

The revisions focused on footnotes for Tables 4.1 and 4.2. BMWA requested

1. inserting "long-term" in the first footnote sentence that describes the TMDL wasteload allocations.
2. deleting "and 1000 ug/L" from the first footnote sentences in Tables 4.1 and 4.2.
3. identifying additional facilities for interim effluent limitations of 1000 ug/L in the second footnote sentence.

The footnote for Table 4.1:

Note: For wasteload allocations, the long-term permit effluent limitations for total phosphorus would be 100 ug/L ~~and 1000 ug/L~~ (as indicated in the Table above, implemented as an annual average plus a 30-day average not to exceed 3 times the annual average at any hydraulic capacity (rated or existing) for the identified wastewater treatment facilities. Interim effluent limitations of 1000 ug/L for the Burlington Pump Works, Littleton-Englewood WWTP, and Centennial WWTP will be implemented as described in Regulation No. 85.

The footnote for Table 4.2:

Note: For wasteload allocations, the long-term permit effluent limitations for total phosphorus of ~~would be~~ 100 ug/L ~~and 1000 ug/L~~ (as indicated in the Table above, would be implemented as an annual average plus a 30-day average not to exceed 3 times the annual average at any hydraulic capacity (rated or existing) for the identified wastewater treatment facilities. Interim effluent limitations of 1000 ug/L for the Burlington Pump Works, RWHTF, Littleton-Englewood WWTP, and Centennial WWTP, as well as for other identified facilities required to achieve long-term effluent limitations of 1000 ug/L, will be implemented as described in Regulation No. 85.

Division Response: The Division incorporated these requested revisions, with some modifications after discussions with BMWA:

> The footnote for Table 4.1:
>
> Note: For wasteload allocations, the long-term permit effluent limitations for total phosphorus of 100 ug/L as indicated in the table above will be implemented as an annual average plus a 30-day average not to exceed 3 times the annual average at any hydraulic capacity (rated or existing) for the identified wastewater treatment facilities. Interim effluent limitations of 1000 ug/L for the Burlington Pump Works, Littleton-Englewood WWTP, and Centennial WWTP will be implemented as described in Regulation No. 85.
>
> The footnote for Table 4.2:
>
> Note: For wasteload allocations, the long-term permit effluent limitations for total phosphorus of 100 ug/L, as indicated in the table above, will be implemented as an annual average plus a 30-day average not to exceed 3 times the annual average at any hydraulic capacity (rated or existing) for the identified wastewater treatment facilities. Interim effluent limitations of 1000 ug/L for the Burlington Pump Works, RWHTF, Littleton-Englewood WWTP, and Centennial WWTP, as well as for other identified facilities subject to Regulation No. 85 and/or required to achieve long-

term effluent limitations of 1000 ug/L, will be implemented as described in Regulation No. 85.

The Division finalized the TMDL package and submitted the TMDL to EPA in May 2013.